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Variation of the chemical composition of four forage shrubs (*Albizia lebbeck, Leucaena leucocephala, Morinda lucida* and *Senna siamea*) in dry season in southeast of Gabon

Férence N.E. MATUMUINI[1*], Arseine Valéry MBOKO[1], Christian MOUPELA[1], Fernand TENDONKENG[2], Gino B. BOUSSIENGUI[1], Gilbert T. ZOUGOU[1], Jules LEMOUFOUET[2], Emile MIÉGOUÉ[2], Audrey A. AKAGAH[1], Benoît BOUKILA[1], Etienne T. PAMO[2]

[1]Institut National d'Agronomie et de Biotechnologies (INSAB). Université des Sciences et Techniques de Masuku (USTM). BP 941 Franceville, Gabon.

[2]Laboratoire de Nutrition et d'Alimentation animale, Département des productions animales, FASA, Université de Dschang. BP 222 Dschang, Cameroun.

*Correspondent author: mat_ference@yahoo.fr

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ABSTRACT

Objective: This study is conducted, to know the chemical composition at different periods of the dry season, of four major fodder shrubs (*Albizia lebbeck*, *Leucaena leucocephala, Morinda lucida* and *Senna siamea*), used to supplement poor fodders in animal feed, in the conditions of southeast Gabon.

Methodology and results: The leaves of each species were harvested at the beginning, at mid-season and at the end of dry season. They were dried and crushed to determine their chemical composition. The results showed that, with *A. lebbeck*, the levels of DM obtained at mid-season and the end that one, were higher (P<0.05) than at the first harvest. The levels of DM and CP obtained at mid-season and the end of dry season, with *L. leucocephala* were higher (p<0.05) than those observed at beginning. Variations of DM and CP levels of *M. lucida* leaves and DM content of *S. siamea* leaves were not significant (p>0.05). In addition, catechic tannins were not found in the leaves of *S. siamea*. However, the variations of this tannins type, observed in the leaves of *L. leucocephala*, *M. lucida* and *A. lebbeck* were not significant (p>0.05). On the other hand, the contents of gallic tannins measured in the leaves of *S. siamea* decreased at the end of the dry season (p<0.05).

Conclusion: Finally, it appears that these species showed few variations in protein, cellulose and tannins throughout the dry season. Taking into account the results obtained, the shrub species studied could constitute good forage in supplementation of poor grass in the dry season. However, *L. leucocephala* and *S. siamea* should be used with much moderation for the feeding of ruminants, given the presence of gallic tannins in their leaves. Nevertheless, it would be important to study the digestibility of these forages in the dry season.

Key words: legumes, *fabaceae*, *rubiaceae*, ruminants, tannins.

INTRODUCTION

Livestock is an important sector in supplying the human population with animal proteins in the world. However, this activity faces many difficulties, notably feeding constraints. Feeding ruminants, for example, is more than 90% supplied by grasses, which cover 70 to 80% of their energy requirements (Jarrige *et al*., 1995) during the rainy season. The use of perennial or annual grasses is limited during the dry season because they are a good nutritive value only during the rainy season (Pamo *et al*., 2007). Therefore, to improve the digestive use of these straws during the dry season, supplementations with concentrate or other plants rich in nitrogenous matter are recommended (Boukila *et al*., 2006). In this context, the use of ligneous shrubs as food supplements could constitute a possible alternative; because they are resistant to drought. However, many of them have the disadvantage of containing anti-nutritional factors such as tannins, which limit their use in animal feed (Makkar, 2003). Even though the condensed tannins or catechic, are harmful only when ingested in large quantities; hydrolyzable tannins, particularly gallotannins, are frequently responsible for food poisoning in ruminants (Mc Sweeney *et al*., 2001, Makkar, 2003). In addition, the knowledge on chemical composition and quality of tannins contained in plants such as *Albizia lebbeck*, *Leucaena leucocephala, Morinda Lucida* and *Senna siamea* would allow their use as food supplements for poor forages in dry season. To contribute to the improvement of knowledge on the use of fodder trees as a food supplement for livestock in the dry season, a study on the chemical composition of these shrubs throughout the dry season was undertaken.

MATERIAL AND METHODS

Study area: The study was conducted at the Institut National Supérieur d'Agronomie et de Biotechnologies (INSAB) of the Université des Sciences and Techniques de Masuku (USTM), between June 15 and October 15, 2014. INSAB is located in Franceville south-eastern of Gabon (1°37'15" south latitude and 13°34'58" east longitude). The climate of the region is equatorial type hot and humid, characterized by four seasons: a great rainy season from mid March to mid June, a great dry season from mid June to mid September, a small rainy season from mid September to mid December and a small dry season from mid December to mid March. Average temperatures range from 24.4 to 26.8 ° C, while annual precipitation ranges from 2000 mm to 2250 mm per year (Van de Weghe, 2008).

Plant material: The plant material consisted of leaves of *Albizia lebbeck, Leucaena leucocephala, Senna siamea* and *Morinda lucida*.

Sample collection: From the middle of June, in a completely randomized device, leaves of the 4 tree species was harvested at random, three times with 45 days frequency, in 4 replicates per species at different points in the City of Franceville. The first harvest period corresponded to the beginning of the dry season, while the second harvest period and the third harvest period corresponded with the mid-season and the end of the dry season. The harvested forages were weighed of and dried in ventilated oven at 60° C, until constant weight was achieved. The dried matter was ground and stored until analysis.

Chemical analysis: The analyses of the chemical composition were carried out at the Nutrition and Animal Feed Laboratory of the University of Dschang in Cameroon. Dry matter (DM) and total nitrogen (MAT) were determined using the methods described by AOAC (2000). Crude fibre (CF) was determined according to the Weende method. Analyzes of anti-nutritional factors including condensed tannins and hydrolyzable tannins were performed at the Laboratoire de Biologie Appliquée at the Université des Sciences et Techniques de Masuku. The tannins were extracted with a water-acetone mixture. They were then characterized by ferric salts: an aqueous solution of 2% ferric chloride (gallic tannins) and an aqueous solution of 2% iron perchloride (catechic tannins). The contents of catechic tannins were determined by precipitation with the Stiasny reagent. The gallotannins were assayed by precipitation after saturation with sodium acetate and iron chloride.

Statistical analysis: For each foliage data of nutrient and catechic tannin contents were analyzed for variance using SPSS 20.0 software. When the differences existed between the species, the averages were separated by the Waller-Duncan test at the 5% significance level. The comparison of the average of the contents of gallic tannins was carried out using the Student test at the 95% confidence interval.

RESULTS

Nutrient levels in leaves of *Albizia lebbeck, Leucaena leucocephala, Morinda lucida* and *Senna siamea* during dry season: Variations of dry matter (DM), ash, crude protein (CP) and crude fibre (CF) content of the different shrub species at each harvesting period are shown in Figures 1, 2, 3 and 4.

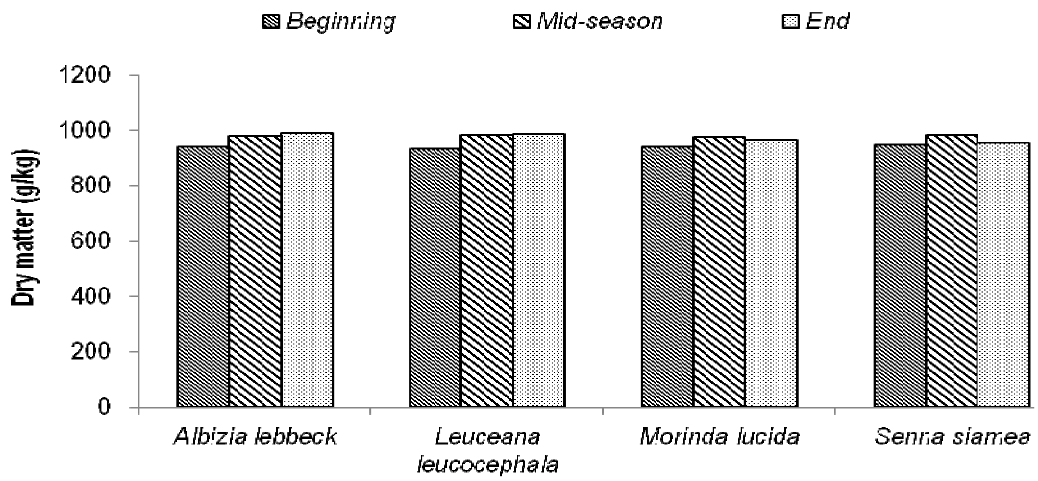

Figure 1: Change in dry matter content of different shrub species in the dry season

The DM content was on average lower in the first harvest period compared to the other two harvests for all species (Figure 1). In fact, DM levels of *A. lebbeck* and *L. leucocephala* increased throughout the harvesting period. Thus, mid-season levels (979.1 and 982.6 g/kg) were comparable (p>0.05) to those recorded at the end of the dry season (989.5 and 983.8 g/kg), but significantly higher (P<0.05) than those observed at the beginning (938.5 and 934.4 g/kg). However, the levels of DM obtained with *M. lucida* and *S. siamea* shown an up and down pattern. Moreover, these changes did not show any significant difference (p>0.05).

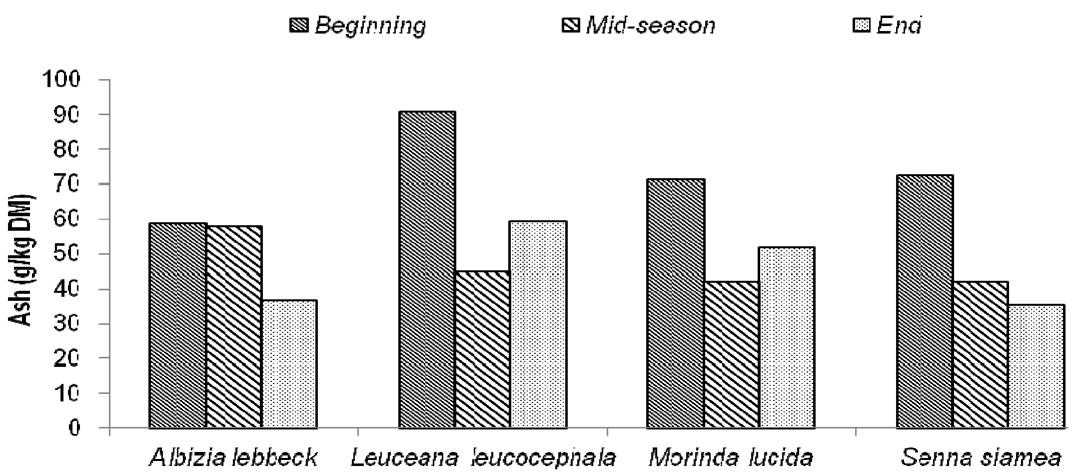

Figure 2: Change in ash content of different shrub species in the dry season

From figure 2, the ash content was higher at the beginning and lower at the mid-season and at the end of dry season, for all the plant species studied. The ash contents obtained with *S. siamea* at mid-season (41.9 g/kg DM) and the end of dry season (35.4 g/kg DM) were comparable (p> 0.05) and significantly lower (p <0.05) than that recorded at the beginning of dry season (72.5 g/kg DM). Similarly, the mineral content obtained with *L. leucocephala* at mid-season (4.47% DM) was significantly lower (p<0.05) than those recorded at the beginning (90.7 g/kg DM) and the end of dry season (59.4 g/kg DM). On the other hand, the ash contents obtained at different periods with *A. lebbeck* (respectively 58.6, 58.0 and 36.8 g/kg DM at beginning, mid-season and the end of dry season) and *M. lucida* (respectively 71.4, 41.9 and 51.7 g/kg DM at beginning, mid-season and the end of dry season) were comparable (p>0.05) for each species.

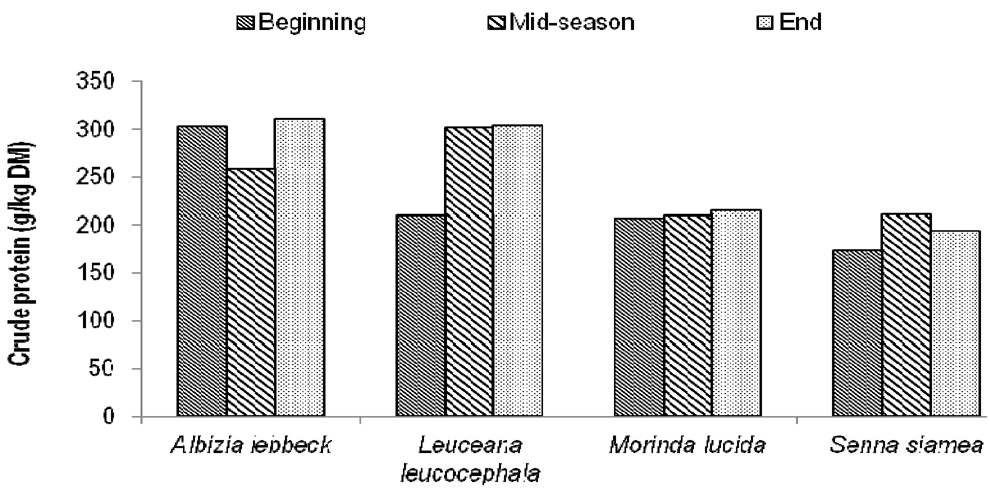

Figure 3: Change in crude protein content of different shrub species in the dry season

Figure 3 shows that the crude protein (CP) content of *M. lucida* leaves did not change (p>0.05) during the dry season (207.1, 210.0 and 214.4 g/kg DM at beginning, mid-season and the end of dry season respectively) (P<0.05) and significantly higher (p<0.05) compared to *L. leucocephala*, at R1 (209.7 g/kg DM). Moreover, the percentages of CP obtained with *A. lebbeck* decreased at mid-season, to get back to the initial value, at the end of dry season and *S. siamea* increased at mid-season and stays stable at the end. Indeed, the CP content obtained with *A. lebbeck* at mid-season (258.3 g/kg DM) was significantly lower (p<0.05) than those recorded at beginning (302.9 g/kg DM) and the end (310.8 g/kg DM), which were comparable (p> 0.05) to each other; Whereas with *S. siamea*, the CP content obtained at the end (193.7 g/kg DM) was significantly greater (p<0.05) than that recorded at the beginning of dry season (173.4 g/kg DM) and significantly lower (p<0.05) than at mid-season (211.2 g/kg DM).

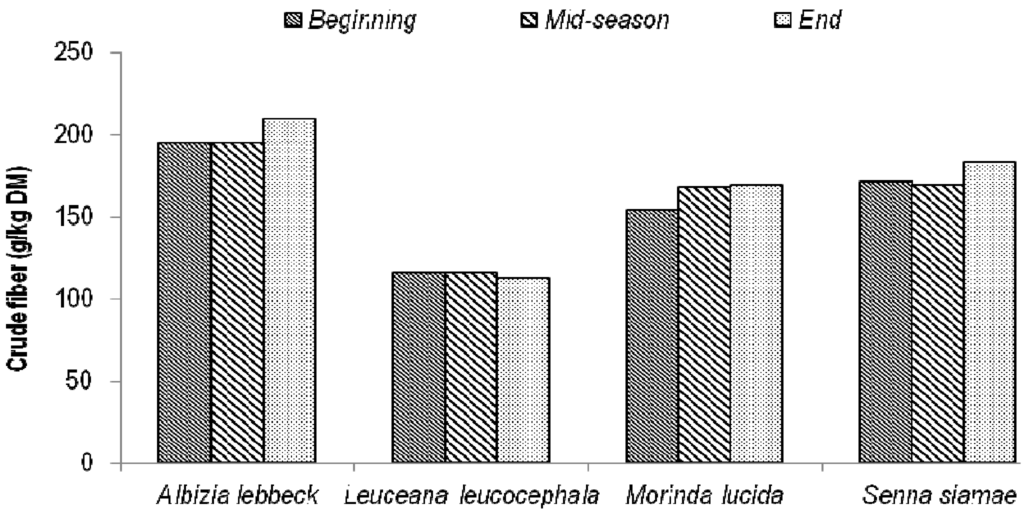

Figure 4: Change in crude fibre content of different shrub species

It can be seen from figure 4 that the crude fibre (CF) content of *L. leucocephala* decreased slightly with harvesting periods (115.9, 115.4 and 112.6 g/kg DM, respectively, at beginning, mid-season and the end of dry season); But this decrease was not significant ($p>0.05$). Similarly, *A. lebbeck* and *M. lucida* showed the highest levels (209.0% and 169.1 g/kg DM) at the end; but, no significant difference ($p>0.05$) observed with the other harvesting periods (195.0 and 153.7 to beginning and 194.7 and 167.8 g/kg DM to mid-season, respectively). In contrast, with *S. siamea* the CF levels obtained at beginning (171.2 g/kg DM) and mid-season (168.7 g/kg DM) were comparable ($p>0.05$) but significantly lower ($p<0.05$) to that observed at the end (182.8 g/kg DM).

Variation in tannin content of different species at each harvesting period: Tables 1 and 2 shows, respectively, the contents of condensed or catechic tannins (CT) and gallic tannins (GT) of the different plant species at each harvesting period.

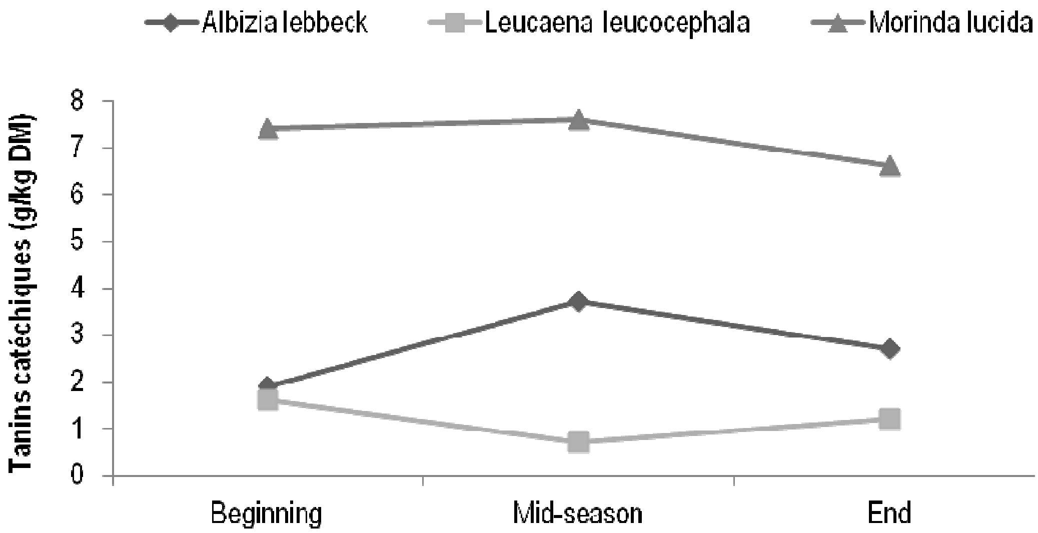

Figure 5: Variation in catechic tannins content of different shrub species in the dry season

Catechic tannins were not observed in the leaves of *S. siamea* (Figure 5). However, the amounts observed in the leaves of *A. Lebbeck* (1.6, 3.7 and 2.7 g/kg DM respectively at beginning, mid-season and the end of dry season), *L. leucocephala* (1.6, 0.7 and 1.2 g/kg DM respectively at beginning, mid-season and the end of the dry season) and *M. lucida* (respectively 7.4, 7.6 and 6.6 to beginning, mid-season and the end of dry season) shown an up and down patterns during the dry season. However, these variations were not significant whatever the species considered (p>0.05).

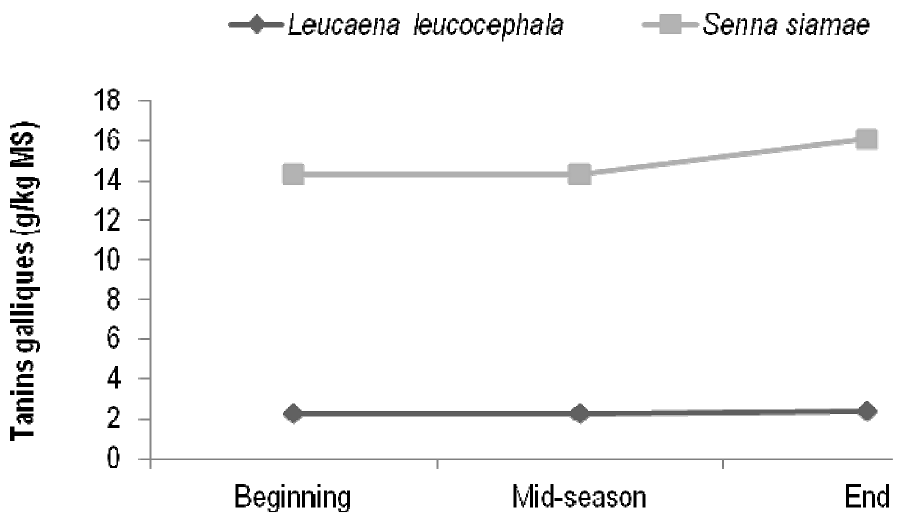

Figure 6: Variation in gallic tannins content of the different shrub species in the dry season

Among the four species studied, gallotannins were only found in leaves of *L. leucocephala* and S. siamea (Figure 6). In addition, the quantities extracted from *L. leucocephala* did not vary (p>0.05) throughout the dry season. Whereas with *S. siamea*, the amounts obtained at the beginning and mid-season were comparable before increasing significantly (p<0.05) at the end of the dry season.

DISCUSSION

Although the levels of DM of *L. leucocephala* and *A. Lebbeck* increased significantly between the first two harvests, the variation of this parameter with *M. lucida* and *S. siamea* was not significant. These differences would be related not only to the advancement of the dry season but also to the phenological stages of the trees during harvesting. This observation is similar to those reported by Bayer and Waters-Bayer (1999) and Arbouche *et al*. (2012), which showed that variation in DM content, may be influenced by the stage of development of the plant. The ash contents obtained with *A. lebbeck* and *M. lucida* were not influenced by the harvesting periods. While those obtained with *L. leucocephala* have significantly shown an up and down pattern throughout the harvesting periods. On the other hand, for *S. siamea*, the decrease in the first two harvest periods was significant. These results would be related to the ability of each plant to withstand water stress as the season progresses, plant age, soil type or availability of minerals in soil at different sampling sites (Kellman, 1979, Isichei and Muoghalu, 1992 and Sirois *et al*., 1998). The CP levels obtained with *M. lucida* were not influenced by harvest periods. However, the rates obtained with *L. leucocephala* increased significantly in the second harvesting period, while the CP levels observed with *S. siamea* and *A. lebbeck* showed an up and down pattern. Nevertheless, the levels obtained for each species during the dry season are above the standard (70 g/kg DM) recommended by Msanga and Bee (2006) and Mrema (2015) for adequate cellulolytic activity of the rumen microflora. This result confirms that these species could be important protein supplements for ruminant feeding in the tropics (Palmer and Tatang, 1996; Pamo *et al*., 2007), especially in the dry season. Moreover, it confirms the assertion that shrub species retain their protein value throughout the year and that it decreases little during the dry season (Jarrige *et al*., 1978; Aufrère *et al.,* 2012). The CF levels obtained with *A. lebbeck* and *L. leucocephala* and *M. lucida* were not influenced by harvest periods. On the other hand, the levels obtained with *S. siamea* increased significantly at the end of the dry season. These variations could be explained by the ability of each plant to ensure its growth kinetics, tolerance to water stress and to the age of the leaves of the plants. This observation corroborates that made by Audru *et al*. (1993) and Aufrère *et al.* (2015) who stated that the dry season and leaf age are factors of variation in CF content. The variations in the quantities of catechic tannins obtained with *A. lebbeck*, *L. leucocephala* and *M. lucida* were not significant. This result is in contrary to those reported by Leinmüller *et al*. (1991), Skadhauge *et al*. (1997) and Laweler *et al*. (2002) who observed an increase in the tannin concentration with drought, nutrient deficiency and stage of development of the plant. These differences are probably related to the intensity and duration of the dry season, the age of the plants and the harvest periods. Nevertheless, in the present study the values obtained (0.7-7.6 g/kg DM) were lower than those reported by Heuzé *et al.* (2015) with *A. lebbeck* (9 g/kg DM) but close to that recorded by Osakwe and Drochner (2006) with *M. lucida* (7 g/kg DM). Of the four shrub species analyzed, only *L. leucocephala* and *S. siamea* showed the presence of gallotannins. The concentration and type of tannins may therefore depend on the specific nature of each plant.

CONCLUSION

Finally, it appears that these species showed few variations in protein, cellulose and tannins throughout the dry season. Taking into account the results obtained, the shrub species studied could constitute good forage in supplementation for grass straws in the dry season. However, *L. leucocephala* and *S. siamea* should be used with much moderation for the feeding of ruminants, given the presence of gallic tannins in their leaves. Nevertheless, to confirm the results of the present work, it would be important to study the digestibility of these forages in the dry season.

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