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Use of Leucaena *leucocephala* in ruminants' feed in Senegal: bromatological study and digestibility

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ABSTRACT

To contribute to a better understanding of the use of *Leucaena leucocephala* in animal feed, studies on its chemical composition and degradability supplemented by dietary trials on cattle, were conducted at the National Livestock and Veterinary Research Laboratory of the Senegalese Institute of Agricultural Research (ISRA-LNERV). Results revealed fairly significant differences of CP, in order of 29.26 ± 2.8 % and 30.07 ± 7.10 % of DM for leaves and pods respectively. The contents levels of calcium and phosphorus were 3.25 ± 1.50 and 0.22 ± 0.07 % of DM, respectively. . The average contents of neutral detergent fiber (NDF) and acid detergent fiber (NDF) of the *Leucaena* leaves were 39.45± 5.48 and 32.65 ±2.70%.of DM, respectively, and the acid detergent fiber (ADF) or lignocellulosic is 32.65 ±2.70%. A relatively low lignin level (17.02 ± 2.70 % of DM) was obtained for the leaves. The average levels of tannins expressed as gallic acid (GA) and tannic acid (TA) in leaves and pods were less than 5% of DM and therefore could not constitute a factor limiting the digestibility of *Leucaena*. Indeed, nearly 80% of DM was degraded after 72 hours of incubation and over 90% of CP was degraded during the same period. The harvest season which had an influence (P <0.01 and P <0.05) on Ca, P, NDF and tannins levels variation, and induced varying (P>0.05) degradability profiles; however these were not significant. Thus, the optimum degradability rates were obtained during the rainy season.

Keywords: Food, ruminants, *Leucaena leucocephala*, Sahel, degradability, harvest season.

INTRODUCTION

One of the main constraints to livestock development in Senegal is inadequate nutrition. Indeed, significant efforts have been made in the field of health; Eradication of rinderpest has been achieved while other major animal diseases such as Bovine Contagious Pleuro-Pneumonia (BCPP) and Pest des Petits Ruminants (PPR) are well controlled through mass immunization campaigns and structured epidemiological surveillance.

Today, an ambitious livestock breeding program with the application of Artificial Insemination (AI) technology is being carried out by the government. However, the renewed government efforts could be jeopardized by inadequate quality-feed supply.

Ruminant livestock in Sub-Sahara Africa are reared mainly on natural rangelands with less than 18 % of farmers practicing feed supplementation (TRAORE et *al*, 2016). However, the combined effect of successive droughts, overgrazing due to the increase in arable land and irrigation schemes, has led to considerable degradation of natural pastures (TRAORE, 2003; TRAORE et *al*).One of the most sustainable solutions options that can be used by farmers, is to improve the availability of fodder through the use of fast growing fodder trees with high yielding potential in terms of biomass production. Among these, *Leucaena leucocephala* is of great importance ; this shrubby plant known in tropical areas of Asia and Latin America (with similar climatic conditions than the ones prevailing in Senegal) has leaves and fruits rich in crude protein (CP), up to35% of DM (RIVIERE 1978; LAMPREY & YUSUF, 1980 KONE, 1987 TOPPS 1992; FALL 1993; TRAORE1998; TRAORE et al., 2016). This plant also contains other nutrients such as carbohydrates, lipids and minerals. It was introduced a few years ago in Senegal's Niayes as windbreaks, live fences, or to stop soil erosion in vegetable farms. Its use in animal feeding remains to be fully understood, although several studies have indicated the influence of mimosine and its metabolites in Livestock.

Toxicity of mimosine may occur due to inhibition of tyrosine utilizing enzyme or incorporation of mimosine into biologically vital proteins in place of tyrosine (Crounse et *al.*, 1962). Montagna and Yun (1963), in their mice studies revealed gross damage including hair follicle possibly due to inhibition of mitotic activity by mimosine. However, in another study, it was suggested that mimosine acts on the proliferative phase of growth i.e., mitotic activity in bulbs rather than a keratinization phase (Hegarty et al., 1964). Thyroxine synthesis is hampered due to prevention of the iodination of tyrosine, a metabolic product of mimosine (Hegarty et al., 1976). Peroxidase which is as much necessary for conversion of iodine to iodine radical or nascent iodine which is important for its incorporation into tyrosine is reduced by 3, 4 DHP, therefore, affecting synthesis of T1, T2, T3 and T4. Circulating DHP also may form complex with Zn and Cu (Stunz iet al., 1980) or Fe and lead to excretion of these metals. Mimosine reduced the activity of aspertate amino transferase, polyphenyl oxidase and ATP production was reduced by 70%. DNA synthesis got adversely affected. However, RNA synthesis remained unhampered. Gupta (1995) reported that the 50% level of *L. leucocephala* leaf meal in rabbit diet reduced the DNA synthesis. Mimosine decreased cell division, DNA, RNA and protein synthesis in Paramecium at submillimolar concentrations

This study is a contribution to a better understanding of the use of *Leucaena* for feeding ruminants. The study of the chemical composition and degradability of leucaena was conducted at the National Livestock and Veterinary Research Laboratory of the Senegalese Institute of Agricultural Research (ISRA-LNERV).

MATERIAL AND METHODS

Study of the chemical composition

Samples

Samples of *Leucaena* leaves were collected throughout the year on a farm (in the Niayes) located 40 km from Dakar. The sampling rate was conducted every 15 days. In total 28 samples of leaves and 04 samples of pods are used for analysis.

Assay

The crude protein (CP) was assayed by the Kjeldahl technique. Parietal components (NDF, ADF, lignin) were assessed by the Van Soest technique (Van Soest, 1963). Calcium (Ca) and phosphorus (P) are determined by the AOAC (1975) method; calcium assay performed titrimetrically, that of phosphorus by calorimetry. All assays were carried out at the feed and Animal Nutrition Laboratory of ISRA/LNERV.

Tannins expressed as gallic acid (GA) and tannic acid (TA) were determined by the calorimetric method of SEIGLER et al. (1986). Tanning essay was conducted at the Laboratory of Botany and Pharmacognosy in the Faculty of Medicine, Pharmacy and Odonto-Stomatology of the University Cheikh A. Diop of Dakar.

Degradation or the cellulolytic ability measuring study

Samples were taken from those used for feed analysis. The samples were ground and sieved using a gate of one millimeter in diameter. The incubation bags are made with nylon fabric (Blutex T50) (Tripette and Renault). The meshes were regular and hada diameter of 46 mm.

A batch of three (03) rumen fistulated Gobra zebu weighing about 400 kg each (*Bosindicus*)were used for experimentation. The animals were kept in stables and receive a standard ration of rice straw offered *ad libitum* and supplemented with one (1) kg of groundnut cake per animal per day and mineral licks as supplement.

Incubation bags containing 5 g sample of *Leucaena* sample were attached along a plastic support, and introduced at the same time, in the morning in the rumen of the fasted animal for incubation. The dysincubation

Table 1: Average chemical composition of the leaves of *Leucaena* depending on the harvesting season and the average content of leaves and pods.

Season of harvest	mean content in % of dry matter						
	CP	MM	Ca	P	NDF	ADF	Lignin
Rainy season	26.85± 6.67	14.23± 4.56	2.49 ± 0.64	0.21 ± 0.04	38.81± 5.49	24.98± 8.38	8.56 ± 2.89
cold dry season	32.51± 4.55	11.40± 1.14	2.77 ± 1.44	0.23 ± 0.05	40.01±11.67	19.85± 1.16	6.70 ± 1.28
hot dry season	30.93± 9.01	16.10± 3.01	6.42 ± 3.73	0.19 ± 0.04	34.06± 9.98	37.60± 6.79	20,.91±4 ,93
beginnig of rain	29.72± 2.65	14.67± 0.88	6.34 ± 0.84	0.17 ± 0.02	44.95± 0.77	38.40± 1.69	15.50±3.95

NB:Rainy season: from July to September; Cold dry season from October to January; hot dry season from February to April; rains start: May-June

(removal of the bags) occurs at 4, 48 and 72 hours meaning three points of sample repeated three times. The dysincubed bags are washed, then crushed by Stomacher (MICHALET-DOREAU & OULD BAH, 1989), to reduce microbial contamination on bags which could affect the assay results; because microorganisms can continue their activity outside the rumen, if conditions are favorable, they can also stay stuck on bags. Chemical analyzes related to different dry matter and crude protein residues and sample substrate, according to the classical method of bromatological analysis already described. The parameters are obtained by a nonlinear regression (Marquard Method NLIN procedure, SAS, 1985). Considering the turnover (k) of feed particles in the rumen degradability of DM and TNM was calculated by the equation:

$$\mathbf{Deg} = \boldsymbol{a} + \frac{\boldsymbol{bc}}{\mathbf{c} + \mathbf{k}\boldsymbol{e}^{-\boldsymbol{kto}}}$$

A k turnover of 0.04 k^{-1} which corresponds to the turn-over of the solid phase in tropical cattle breeds (DOLL-Lechner et al, 1990) is used.

RESULTS AND DISCUSSION

Chemical composition

The average CP content of *Leucaena* leaves is 29.26 ± 2.80% of DM ; the extreme concentrations being 15.80 and 38.90% of DM. It was noted that the similar content was in the pods ; there was no difference in CP levels (30.07 ± 7.10%) between leaves and pods. The harvest period also has no influence on CP levels of *Leucaena*. However, the highest levels were recorded in the rainy season (Table 1). Observed concentrations are higher than those reported by GUERIN (1987) on other ligneous such as *Balanites aegyptiaca* (desert date) *Boscaia senegalensis*, or *Giuera senegalensis* which are 10 to 12% of DM. The observed levels are well above the levels of CP in Sahelian rangelands during the dry season when average is around 5% of the DM (RICHARD et al;. 1989; AKPO, 1993); this justifies the use of ligneous to supplement feed rations for animals in pasture. According to FALKER (1980) and TOPPS (1992), fodder trees are richer in CP, compared to other plants, and this may be due to their root systems allowing them to withdraw water and nutrients, but also by their high capacity to fix atmospheric nitrogen.

The mean levels of ashes from mineral elements are 15.06 ± 1.75 and13.75 ± 1.42 %of DM for leaves and pods respectively. Calcium levels did not change significantly between the leaves and pods (3.25 ± 1.50 and 4.09 ± 1.02 %, respectively). That of phosphorus also varies little between the leaves and pods: 0.22 ± 0.07 and 0.20 ± 0.05.

It is noted a significant variability for the calcium and phosphorus both (P <0.05) depending on the harvest period. Indeed, very high levels of calcium were observed in hot dry season and the beginning of rainy season with6.42 ± 3.73 and 6.34 ± 0.84, are respectively. Regarding phosphorus, high levels were recorded in the rainy and during the cold dry seasons: 0.21± 0.04 and 0.23 ± 0.05 respectively (table 1&2). However, the levels found are high enough to justify the possible use of fodder trees, including *Leucaena*, to supplement feed rations of ruminants without the need of using a supplement of calcium or phosphorus.

The digestibility of fodder trees by ruminants is largely conditioned by their content of total fiber. Van Soest (1982) noted that the abundance of cell walls including lignocellulose has a negative effect on digestibility.

Leucaena leucocephala leaves average content of total wall (NDF) is 39.45 ± 5.48%. Lignocellulosis (ADF), and lignin contain are respectively 32.65 ± 3.51 and 17.02% ± 2.70%. Those of pods are slightly higher numerically: 41.70 ± 4.8; 48.50 ± 5.42 and 22.27 ± 4.98%

Table 2:Mean contents of leaves and pods

Matters	Means contains in % of dry matter						
	CP	MM	Ca	P	NDF	ADF	Lignin
Average of leaves	29,26 ± 2,80	15,06 ± 1,75	3,95 ± 1,50	0,22 ± 0,07	39,45 ± 5,48	32,65 ± 3,51	17,02 ± 4,98
Average of pods	30,82 ± 2,33	13,75 ± 1,42	4,09 ± 1,07	0,20 ± 0,05	41,70 ± 4,38	38,50 ± 5,42	22,27 ± 4,98

Table 3: Levels of gallic acid and tannic acid (% DM) leaves *Leuceana* depending on the harvesting season and the phenological stage**.**

Tannin % DM	Levels according to harvest season				levels according to phenologic period			
	Rainy season.	Cold dry season	Hot dry season	Beginning of rain	Fruiting.	Flowering.	Regrow.	Intermediary
GA	4,43	3,64	3,55	3,15	4,34	3,25	2,42	5,34
TA	5,54	4,60	5,04	4,02	5,48	4,39	3,98	6,72

respectively, but the differences were not significant. KONE (1987) and FALL (1993) having worked on other fodder tree species found similar results (40 and 42% of ADF content). There is certainly a climatic influence on the levels of total ligneous walls. Because our results are lower than those reported by LAMBERT et al. (1989) and TOPPS (1992) at the temperate ligneous fodder (60% NDF).

The harvest season has a significant influence (P <0.01) on the wall content including ADL (lignocellulosis) and lignin. The highest levels are observed in hot dry season; when the leaves are older and well encrusted lignin. The lowest rates are found in the cold dry season and they are respectively: 19.85 t ± 6.79 and 20.91 ±1,28% for ADF and lignin against 37.60 ± 1.16 and 6.70 ± 4.93% in the hot dry season (table 3).

The average levels of tannin expressed in gallic acid (GA) and tannic acid (TA) on leaves of *Leucaena* are 3.85 ± 1.67 % and 4.56 ± 1.55 % respectively. These levels were 3.12 ± 0.53 and 4.20 ± 1.01, respectively for pods. The levels vary significantly (P <0.01) with the harvest season; the highest levels were observed during the rainy season and the cold dry season: 5.54% and 4.60% respectively of AT. These two seasons are not water-stress seasons, higher tannins rates observed in these periods would certainly be due to fruiting. It is now known that plants take a defensive response during periods of high stress or fruiting by secreting chemicals toxic to allow the plant to ensure the sustainability of the species, 1975 (COLEY et al.); KUMAR SINGH & 1984; BARRY & MANLEY, 1987).

However, average levels observed were lower than or close to 5%, suggesting that the tannins are not a limiting factor for the use of *Leucaena* in ruminants feeding.

Insacco Degradability

The degradability of dry matter (DM) of *Leucaena* leaves is good. It is close to the third or 30.25 ± 6.01 %, after 4 h of incubation. More than three quarters of DM are degraded after 48 hours meaning 76.49 ± 3.12% and, about 80% of DM is degraded in 72 of h incubation (Table 4). CP are degraded more than 40% in 4 hours' incubation, about 90% after 48 h, and 93.59 ± 3,81% after 72 hours of incubation. The degradability rate observed are slightly higher than those reported by FALL (1993): and MICHALET - DOREAU & OULD BAH, 1989 to the same incubation times and which were 27 to 85.7 %. Also, we cannot accurately predict the degradability of CP from that of DM: CP 48 ***Deg = 0.31 Deg 48 MS + 61.43; R = 0.27; ETR = 9.26; n = 12*** **P < 0,02**. Although not significant, the season has an influence on the degradability profile both of dry matter (DM) as nitrogenous materials (CP). Thus, the best rates for DM degradability were noted in hot dry season and rainy season, the lowest degradability rate being recorded in the beginning of rainy season. Regarding the degradability of nitrogen, the best degradability rates are obtained in the rainy season (beginning and during rainfall) while low degradability rate are noted in the dry season.

CONCLUSION

These results confirm the importance of the use of *Leucaena* leaves and pods in ruminants feeding, because leaves and pods have good digestibility. Their high crude protein contents and relative low tannin levels, suggest their usefulness in feeding ruminants. However, given the possibilities of intoxication by the presence of mimosine (HEGARTY and al., 1976), it is recommended to feed animals in confinement to avoid high rates of ingestion.

Further studies are underway to determine the optimal levels for fattening animals and lactating females and study of possible chronic poisoning effects by

Table 4: Average biodegradability ratio (% MS) versus time and season

Saisons	Average degradability level (% DM) according hours of incubation					
	Degradabilityof DM			Degradabilityof CP		
	Deg 4	Deg 48	Deg 72	Deg 4	Deg 48	Deg 72
Rainy season.	37,20 ± 1,60	77,66 ± 1,45	79,33 ± 0,30	52,85 ± 9,97	93,61 ± 4,48	98,24 ± 1,70
Cold dry season	28,63 ± 0,05	75,93 ± 1,24	76,58 ± 1,12	26,95 ± 6,16	85,75 ± 3,84	89,59 ± 0,95
Hot dry season.	33,03 ± 3,13	79,73 ± 1,28	83,40 ± 0,81	47,32 ± 5,29	89,31 ± 0,95	91,88 ± 0,51
Beginning of rain	22,16 ± 0,70	72,63 ± 2,80	78,45 ± 1,21	40,24 ± 9,95	86,96 ± 6,60	94,37 ± 3,14
Average of DM	30,25 ± 6,01	76,49 ± 3,12	79,64 ± 2,51			
Average of CP				41,34 ± 9,94	88,87 ± 5,16	93,59 ± 3,81

consumption of *Leucaena*. However, on pasture free areas, animals can well regulate their level of intake by consuming other forage in combination with *Leucaena.*

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REFERENCES

AKPO L E (1993). Influence de l'arbre sur la composition minérale de la strate herbacée d'une phytocoenose sahélienne au Nord du Sénégal (Afrique Occidentale). *Annali di Botanica* **11** : 21-32.

AOAC (1975). (Association of Official Agricultural chemists).Official methods of analysis, 12th Ed AOAC.Washington D C.

BARRY T N, MANLEY T R (1986). Inter-relationships between the concentrations of total condenced tannins, free condenced tannins and lignin in *Lotus sp*. And their possible consequences in ruminant nutrition. *J.Sci. Agri.* **37**:248-254.

COLEY P D, BRUYANT J P,CHAPAIN S(1975). Ressource availability and plant anyi herbivore defense.*Sci*. **230**:895-899.

EL HADJI T, AMADOU D, SAMBA NAA, ABDOULAYE F, FARA M (2012). Promoting use of ligneous fodder, for goats feeding in tropical area: integration of *Harwickia binata* Roxb. on dairy goats (Murciano-Granadina) diet in Senegal. XI *International Conference on Goat* Gran Canarie, Spain : 24 - 27

EL HADJI T, MOUSSA C, SALIOU N, CHEIKH S, CHEIKH M. BOYE ET ADJA R D (2016). Note on available feed for livestock in eastern Senegal and upper Senegal river basin. *Int. J. Adv. Res. 4(8) : 2123-2128*

FALL ST (1993). Valeur nutritive des fourrages ligneux. Leur rôle dans la complémentation des fourrages pauvres des milieux tropicaux. Thèse Doct. Univ. Sci. &Techn. Languedoc, ENSAM Montpellier France ; 143

FELKER P, CLARK P R, OSBORN J, CANNEL G H (1980). Nitrogen cycling-water use efficiency interactions in semi-arid ecosystems in relation to management of tree legumes (*Prosopis*). In *H. N. Le Houérou Ed. Browse in Africa* : 215-222.

GUPTA HK (1995). MIMOSINE DEGRADATION, ITS RESIDUAL EFFECT ON MILK AND MEAT IN ANIMALS ON LEUCAENA LEUCOCEPHALA DIET. PH.D. THESIS, SUBMITTED TO NDRI (DEEMED UNIVERSITY), KARNAL**.**

GUERIN H (1987). Alimentation des ruminants domestiques sur pâturages naturels sahéliens et shélo-soudanien : étude méthodologique dans la région du Ferlo au Sénégal. Thèse Doct. Ing. Agro. ENSA Montpellier: 211.

HEGARTY MP, SCHINCKEL PG, COURT RD (1964). Reaction of sheep to the consumption of Leucaena glauca Benth and to its toxic principle mimosine. Aust. J. Agric. Res., 15: 153-167.

HEGARTY M P, COURT R D, CHRISTIE G S, LEE CP (1976). Mimosine in *Leucaenaleucocephala* is metabolised to goitrogen in ruminants. *Austr. Vet. J*. **52** : 490-493.

KONE A R (1987). Valeur nutritive des ligneux fourragers des régions sahélienne et soudanienne d'Afrique Occidentale. Recherche d'une méthode simple d'estimation de la digestibilité et de la valeur azotée. Thèse Doct. 3èmeCycle Univ. P. & M. Curie. Paris VI, 131.

KUMAR R, SING M (1984). Tannins: Their adverse role in ruminant nutrition. *J. Agric. Food Chem*. **32**: 447-453.

LAMPREY H F, YUSUF H (1980). Pastolralism and desert encroachment in Northern of Kenya.*Ambio*. **X** : 131-134.

MICHALET-DOREAU B, OULD BAH M Y (1989). Estimation of the extent of bacterial contamination in bag residue its influence on in sacco measurements of forage nitrogen degradation in rumen. In Proc. *XVI th Int. Grassld. Congr*. : 909-910.

MONOJ K G, SAMIRAN B (2007). Mimosine Toxicity-A Problem of *Leucaena* Feedingin Ruminants . *Asian J. of Ani. and Vet. Advances, 2: 63-73.*

RICHARD D, GUÉRIN H, FALL S T(1989). Feed in the dry tropics. In R. Jarrige Ed. Ruminants nutrition.*Reomended allowance and feed tables, INRA*, France: 345-357.

SEIGLER D S, SEIKHIMER S, KEESY J, HUANG H (1986). Tannins from four common *Acacia speies* of Texas and Northeastern Mexico.*Economic. Botany*. 40 : 220-232

STUNZI H, HARRIS RLN, PERRIN DD, TEITEL T (1980). Stability constants for metal complexation by isomers of mimosine and related compounds. Aust. J. Chem. 33: 2207-2220.

TOPPS J H (1992). Potential composition and use of legume shrubs and tree as fodders for livestock in tropics.*Arevie J. Agric*. *Sci*. **118** : 1-8

TRAORE E H (1998). Facteurs de variation de la composition chimique et de la digestibilité des ligneux consommés par les ruminants domestiques au Sahel. Thèse Doct. 3ème Cycle es Science. Univ. C A Diop Dakar : 95.

TRAORÉ E H, FALL S T, FRIOT D (1995). Influence du taux de *Leucaena leucocephala* sur la croissance et la consommation des ruminants. Comparaison du comportement de bovins et des ovins. Actes séminaire-atelier sur la production intensive de viande en Afrique sub-saharienne, Mbour, Sénégal. Ed. S. T. Fall et A. Faye: 294-301 (1999).

TRAORÉ E H, FALL S T, BASSENE E (1996). Facteurs de variation de la teneur en tanins de cinq ligneux utilisés e alimentation des ruminants au Sahel. Actes 2ème journées annuelles de SOACHIM (Société Ouest Africaine de Chimie) Dakar. Recueil des travaux scientifiques (1): 37-40.

VAN S P J (1963). Use of detergents in the analysis of fibrous feed II. A rapid method for determination of fiber and lignin.*J. A. O. C*. **46**: 829-835.