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Comparative study of chemical composition of three forages from South-East Algeria

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Abstract. The nutritive value of arid browse collected from South-East of Algeria at Biskra was studied on the basis of their chemical composition: dry matter (DM), organic matter (OM), ash, crude protein (CP), ether extract (EE), fiber: NDF, ADF, ADL and acid insoluble ash (ASHINS), Ca, P, Na, K, Mg, Cu, Zn and Mn. The browse species evaluated were the herbaceous *Cynodon dactylon*, *Cyperus conglomeratus* and the tree fodder *Tamarix africana.* Dry matter ranged from 253 to 509 g/kg fresh matter. The OM, CP, NDF and ADF contents in all plants ranged from 830 to 867, 110 to 143, 451 to 710, and 271 to 387 g/kg DM respectively. Acid insoluble ash and ADL levels were high in *C. dactylon*: 74 and 111g/kg DM respectively. Minerals contents in all plants varied widely. Macro minerals were present in sufficient concentrations to meet ruminant's requirement. Trace minerals levels were marginal in terms of requirements. *C. conglomeratus* had a high Mn level (187 mg/kg DM).

Keywords. Chemical composition – Nutritive value – Arid and semi-arid area – Forage plants.

Etude comparative de la composition chimique de trois plantes fourragères du Sud-Est algérien

Résumé. *La valeur nutritive des plantes fourragères de la zone aride du Sud-Est de Biskra en Algérie a été déterminée en se basant sur leur composition chimique. L'analyse a concerné les nutriments suivants. matière sèche (MS) matière organique (MO), matière minérale, les protéines, les extraits éthérés, les fibres NDF, ADF et ADL, les cendres insolubles dans l'acide et les minéraux (Ca, P, Na, K, Mg, Cu, Zn et Mn). Deux plantes herbacées,* Cynodon dactylon *et* Cyperus conglomeratus *et l'arbre* Tamarix africana *ont été prélevés. Les taux de MS varient de 253 à 509 g/kg de la matière fraiche. Les teneurs en MO, en protéines et en fibres NDF et ADF déterminées dans toutes les plantes sont variables respectivement de 830 à 867, 110 à 143, 451 à 710, et de 271 à 387 g/kg MS. Les teneurs élevées en cendres insolubles et en ADL ont été observées chez* C. dactylon*: 74 et 111g/kg MS respectivement. Les teneurs en minéraux varient d'une plante à une autre. Les minéraux majeurs sont présents en quantité suffisantes pour répondre aux besoins des ruminants. Les éléments trace sont déficitaires dans la majorité des plantes.* C. conglomeratus *avait le taux le plus élevé en Mn (187 mg/kg MS).*

Mots-clés. *Composition chimique – Valeur nutritive – Zones aride et semi-aride – Plantes fourragères.*

I – Introduction

The main forage plants in South-East of Algeria are the halophyte shrubs, some trees and herbaceous plants. The contribution of this native pastures to the nutritional requirements of domestic animals is important in this area. Scarce and irregular precipitations, excessive temperatures, drought, salinity and evapotranspiration in this area influence the life cycle and annual regrowth of xerophytes plant (Haddi *et al*., 2009). The herbaceous plants like *Cynodon dactylon* and *Cyperus conglomeratus* are well utilized by ruminants. Besides, our attention is focused on the tree *Tamarix Africana* following its abundance in this area, its utilization as browse by small ruminants and dromedaries and in addition it is evergreen over the year. The present study was undertaken to assess and compare chemical composition of the following herbaceous: *C. dactylon, C. conglomeratus* and the Tamaricaceae tree *T. africana, to* understand if the domestic animals meet their

needs in terms of energy, nitrogen and mineral nutrients in these regions and to help to manage better the animal production and avoid possible nutritional deficits and their consequences on animal health.

II – Materials and methods

This study was carried out in south-east of Biskra at El-Haouch locality (5 N28'E30'15') in south-eastern Algeria. Forage plants were collected monthly (when available) from October 2002 to July 2003. *C. dactylon* and *C. conglomeratus* (as grass plant) were sampled at ten and seven occasions respectively. *T. Africana* (as a tree from Tamaricacae family) was sampled at nine occasions. All plants were dried in air forced oven at 55°C for 72h and milled to pass 1mm screen and stored in polypropylene bottles for subsequent analysis. Dry matter (DM), ash, crude protein (CP), ether extract (fat) were determined using the AOAC procedures (AOAC, 1990). Calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), copper (Cu), zinc (Zn) and manganese (Mn) were determined using an atomic absorption spectrophotometer after wet digestion in nitric and perchloric acid (Arab *et al*., 2009). The photometric method using molybdovanadate was used to measure phosphorus (P) concentrations in the forage plants (AOAC, 1990). Contents of neutral detergent fiber (NDF), acid detergent fiber (ADF) were analyzed according to Van Soest *et al*. (1991). Acid detergent lignin (72% H_2SO4, ADL) and acid insoluble ash (ASHINS) were determined as described by Robertson and Van Soest (1981). All samples were analyzed in duplicate. The chemical composition data obtained were analyzed statistically by using SAS procedure (1989). We performed a one-way factor analysis of variance by performing the Fisher multiple tests with significance levels of 5%.

III – Results and discussion

Table 1 shows the chemical composition of the forage. The DM levels were significantly high ($P<0.05$) in *T. africana,* and *C. dactylon* (509, 484 g/kg of fresh matter) compared with the level observed in *C. conglomeratus*. Our results are comparable with those obtained in shrubs located in North-West of Tunisia ranging from 26 to 53% (Ammar *et al*., 2005). OM levels were significantly higher in *C conglomeratus* (867 g/kg) compared to the levels of those observed in *C dactylon* and *T. Africana* respectively 830 and 837 g/kg. The herbaceous *C. dactylon* had a low DM level (830 g/kg), lower than the same plant in the tropical region: 945 g/kg. The ASHINS (insoluble ash) levels were significantly high ($P<0.05$) in *C. dactylon* and *C. conglomeratus* (74 and 53 g/kg DM respectively). This is explained by the nature of the plants that grow close to the ground and in the wadi beds and floodplains. Besides, climate in arid zones influences significantly and results in an abundance of ash and insoluble ashes (ASHINS) in forage. However *T. africana* had a low level of ASHINS (13 g/kg DM) compared to those of grain ranged from 28 to 41 g/kg DM (unpublished data).

The ether extract (EE) concentration in different plants species was low and ranging from 14 to 15 g/kg. These levels are very low compared to those obtained in trees at South-Africa ranging from 33 to 44 g/kg DM (Lukhele and Van Ryssen, 2003). Feedstuffs containing less than 80 g/kg DM of CP cannot provide the minimum ammonia levels required by rumen microorganisms to support optimum activity (Al-Masri, 2013).

The herbaceous *C. conglomeratus* and the fodder tree *T. Africana* had an essential content of CP respectively 143 and 142 g/kg DM versus 110 g/kg DM for *C. dactylon*. In many regions from the world, trees have been used as feedstuffs for livestock, mainly because of their high protein contents throughout the year that can be attributed to the ability of these plants to fix atmospheric nitrogen. All the plants contained high fiber (NDF and ADF) and the differences between forage species NDF and ADF contents were statistically significant ($P<0.05$) (Table 1).

Table 1. Chemical composition (g/kg DM) of arid plants (mean ± SD)

Forage	DM	OM	ASHINS	EE	CP	NDF	ADF	ADL
C. dactylon (n = 10)	$484^{a} \pm 12$	$830^{b} \pm 73$	$74^{a} \pm 21$	14 ± 0.4	$110^{b} \pm 22$	$710^{a} \pm 29$	$387^{a} \pm 70$	$111^{a} \pm 20$
T. Africana (n = 9)	$509^{a} \pm 76$	$837^{b} \pm 66$	$13^{c} \pm 14$	15 ± 0.4	$142^{a} \pm 41$	$451^{b} \pm 24$	$271^{b} \pm 26$	$89^{b} \pm 26$
C. conglomeratus (n = 7)	$253^{b} \pm 58$	$867^{a} \pm 15$	$53^{b} \pm 19$	15 ± 0.4	$143^{a} \pm 21$	$656^{a} \pm 12$	$344^{a} \pm 11$	$72^{b} \pm 29$

DM: dry matter; OM: organic matter; EE: ether extract; CP: crude protein; NDF: neutral-detergent fiber; ADF: acid-detergent fiber; ADL: lignin. ^{a,b,c,} Means in the same columns for each parameter with different superscript are different at P <0.05.

The NDF and ADF fiber are ranged respectively from 451 to 710 g/kg DM and from 271 to 387 g/kg DM. Similar results were reported for Tunisian and Mediterranean fodder shrubs (Ammar *et al.*, 2005) and for fodder trees from Syria (Al-Masri, 2013). It's known that the lignin is a physical barrier to microbial enzymes and the lignin concentration of forages is negatively related to the extent of digestion. *C. dactylon* was more lignified (P<0.05) than the two other species. The macro and trace mineral concentrations in different plants are presented in Table 2. Mineral imbalances (deficiencies or excesses) in soils and forages have long been held responsible for low production and reproductive problems among grazing ruminants (Mcdowell and Valle, 2000). All plants had P content varied from 2 g/kg (*T. africana*) to 3 g/kg DM (*C. conglomeratus*). These levels are higher than that of trees fodder reported by Lukhele and Van Ryssen (2003) in South Africa. *T. Africana* had a high level of Ca: 21 g/kg DM. Ca: P ratio varied widely, being particularly high in *T. Africana* (11 g/Kg DM). The Ca: P ratios ranged from 1:1 to 2:1 are ideal for growth and bone formation for ruminants. Low P and high Ca concentration resulted in an unusually wide Ca: P ratios. It seems that browsing small ruminants (goats, sheeps and white-tailed deer) can sustain high Ca: P without being affected P metabolism (Ramírez-Orduna *et al*., 2005). Levels of K and Na were high in different plants. The Mg concentration ranged from 2 to 9 g/kg DM in respectively *C. conglomeratus* and *T. Africana*. According to recommend requirements for ruminants (see Table 2), macro mineral levels in studied plants were well above requirements.

Table 2. Mean concentrations of minerals in the different plants species (g/kg DM for macro minerals and mg/kg DM for trace minerals)

Forage	P	Ca	Ca/P	K	Na	Mg	Mn	Cu	Zn
C. dactylon (n = 10)	$3^{a} \pm 0.4$	$13^{b} \pm 2$	$5^{b} \pm 1$	$30^{b} \pm 5$	$6^{c} \pm 1$	$3^{b} \pm 0.4$	$56^{b} \pm 24$	9 ± 2	$56^{a} \pm 7$
T. Africana (n = 9)	$2^{b} \pm 0.6$	$21^{a} \pm 8$	$11^{a} \pm 5$	$24^{b} \pm 6$	$46^{a} \pm 24$	$9^{a} \pm 4$	$27^{c} \pm 11$	9 ± 3	$42^{b} \pm 10$
C. congl. (n = 7)	$3^{a} \pm 0.6$	$10^{b} \pm 3$	$4^{c} \pm 1$	$62^{a} \pm 17$	$12^{b} \pm 5$	$2^{b} \pm 0.4$	$181^{a} \pm 71$	11 ± 2	$33^{c} \pm 6$
Ruminants requirements (mg/kg DM)*	1.8-4.8	1.8-8.2	–	6-8	0.6-1.8	1-2	50-60	10	50-60
Goat requirements (mg/kg DM)**	2.7	2.6	–	2.2	0.7	1.7	30	9	30

^{a,b,c,} Means in the same columns for each parameter with different superscript are different at P <0.05.

* Recommended requirements by (INRA, 1978 and Meschy, 2010).

** Recommended requirements by (NRC, 1981; Kessler, 1991 and Ramírez-Orduna *et al*., 2005).

Trace mineral concentrations of the three arid forages varied from deficient, lower and sufficient than the requirements for domestic ruminants according to the NRC (1981) and those reported by Meschy (2010). The Mn level in *C. conglomeratus* (181 mg/kg DM) was significantly higher ($P<0.05$) compared to other plants. The Cu concentrations in all plants were similar and the difference observed is not significant ($P>0.05$).

IV – Conclusions

Forage plants studied from arid area are essential in supporting basic nutritional requirements of domestic ruminants. The CP content in *T. Africana* and *C. conglomeratus* could be effective protein supplements for ruminants grazing poor quality grass. Regarding major minerals in these plants they were present at sufficient levels to fulfill in the requirements of ruminants. However, trace mineral was slightly deficient and supplementation could be necessary.

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