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Feed Intake and *in Vivo* Digestibility of Dominant Forage of Natural Pasture Supplemented with *Acacia albida* Leaves in Arab Ewes

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Abstract

A study on the feed intake and *in vivo* digestibility of dominant forages on natural pasture supplemented with *Acacia albida* leaves in Arab ewes was conducted from September to October 2020 at the small ruminant station of the Livestock Research Institute for Development (IRED) in N'Djamena, Chad. Sixteen (16) Arab ewes were divided into four groups of four animals each and housed in individual metabolic cages. The adaptation and data collection (urine and feces) periods were 14 and 6 days, respectively. Four rations were formulated. These rations were randomly assigned to each group for the different studies. The rations were as follows: group 1: Dominant forages + 0g of *Acacia albida* leaves; group 2: Dominant forages + 400g of *Acacia albida* leaves; group 3: Dominant forages + 600g of *Acacia albida* leaves; group 4: Dominant forages + 800g of *Acacia albida* leaves. The supplement improved the intake of dominant forages of natural pasture as well as the intake of Dry Matter (DM), Organic Matter (OM), Crude Protein (CP), and Crude Fiber (CF). Similarly, the addition of the supplement significantly influenced the nutrient digestibility of dominant forages of natural pasture in Arab ewes. Indeed, the best digestive utilization of DM, OM, CP and CF (80.91±2.40; 83.35±2.14; 83.47±4.41 and 81.96±2.35) was obtained with the ration containing 400g of *Acacia albida* leaves. The use of 400g of *Acacia albida* leaves as a protein supplement in the diet of Arab ewes is recommended during long periods of drought.

Key words: *Acacia albida*; Arab ewes; Feed intake; *in vivo* digestibility; dominant forages.

Introduction

In Chad, livestock in general and small ruminants in particular play a very important role in the country's economy. It helps reduce poverty and improve food security. Livestock accounts for 53% of the Gross Domestic Product (GDP) and provides a living for approximately 76.2% of the Chadian population [1, 2]. The livestock population, which used to consist of more than 94 million heads of livestock, all species combined [3], now includes 113.56 million heads of livestock, 84 million heads of small ruminants and 35.63 million heads of poultry [4]. However, in Chad, low rainfall has led to a drastic decline in animal production as a result of food shortages, which are the main handicaps to sheep farming. In fact, long periods of drought usually lead to the lignification of existing grasses, which necessitates their supplementation with protein supplements. However, the use of agricultural by-products (tops, peelings, etc.) and agro-industrial by-products (oilcake, spent grain, etc.) has often been encouraged, but generally seems to be very expensive. Thus, the use of existing less expensive non-conventional resources such as *Acacia albida*, which is very leafy during this long period of drought, can solve the problem in ruminants in general and ewes in particular. These plants can also be useful for soil improvement if their adopted as in agroforestry and agrostology. A study with satisfactory results have been conducted on *Acacia albida* pods [5]. However, very little work has been done on the use of its leaves as feed supplement in ewes. Hence there is need to evaluate feed intake and digestibility *in vivo* of dominant forages of natural pasture supplemented with *Acacia albida* leaves in Chadian Arabian ewes.

Material Et Methods

Study Area

This study was conducted between September and October 2020 at the small ruminant station of the Livestock Research Institute for Development (IRED), in N'Djaména, Chad. IRED is located in the 1st subdivision of N'Djamena between 15°02 East and 12°08 North at the confluence of the Chari and Logone rivers. The city of N'Djamena is located in the Sahelo-Sahelian zone with a dry tropical climate. The year consists of two seasons: the dry season and the rainy season. The rainy season runs from June to September with an average rainfall that varies from 400 to 800mm along the North-South gradient [6]. The dry season, which lasts 8 to 9 months, is marked by a hot, dry Harmattan, wind that sweeps across the territory along the Northeast Southwest axis. Temperatures vary between 20°C and 40°C.

Animal Equipment and Health Protection

A total of 16 animals were housed individually in digestibility cages on stilts measuring 1.5m long, 0.5m wide and 1.6m high, equipped with a feeder, a drinking trough, a urine and feces collecting device. Age was determined by teething analyzing method (average 20 months) [7]. There are two methods of dental age assessment, radio graphically and by clinically visualization of eruption of teeth. The clinical method to assess dental age is based on the emergence of teeth in the mouth. Eruption times and wear of the teeth are the major factors used to estimate ruminant age. The definition of eruption is the emergence, penetration or piercing of the tooth or teeth through the gingiva (the gum line). An animal at 14 months of age would have a full set of deciduous incisors. Animals were identified with the help of collar worn around the neck. They were treated with long-acting oxytetracyclin (1ml/10 kg of animal body weight and intramuscularly) and levamisole 10% (1ml/10 kg body weight per animal once a month) active on adult gastrointestinal and pulmonary parasites.

Plant Material

Plant material consisted of the most abundant basic forages in the pasture (Dactyloctenium aegyptium, Cenchrus ciliaris, Panicum maximum) and *Acacia albida* leaves. These forages were harvested each morning for feeding the animals in the sled. Indeed, 300g of Dactyloctenium aegyptium + 300g of Cenchrus ciliaris + 600g of Panicum maximum were harvested and then chopped and the whole mixture constituted the dominant forage of natural pasture.

Four rations were formulated. These rations were randomly assigned to each group for the different studies. The rations were as follows:

- R1- 300g of *Dactyloctenium aegyptium* + 300g of *Cenchrus ciliaris* + 600g of *Panicum maximum* + 0g of *Acacia albida* leaves: control (group 1);

- R2- 300g of *Dactyloctenium aegyptium* + 300g of *Cenchrus ciliaris* + 600g of *Panicum maximum* + 400g of *Acacia albida* leaves: (group 2);

- R3- 300g of *Dactyloctenium aegyptium* + 300g of *Cenchrus ciliaris* + 600g of *Panicum maximum* + 600g of *Acacia albida* leaves: (group 3);

- R4- 300g of *Dactyloctenium aegyptium* + 300g of *Cenchrus ciliaris* + 600g of *Panicum maximum* + 800g of *Acacia albida* leaves: (group 4).

The choice of the *Acacia albida* leaves levels of supplementation was based on the availability and the potential level of antinutritionals factors.

Experimental Design and Data Collection

For this experiment, 16 ewes (four groups of four animals each) with an average weight of 20.3±1.2 kg and approximately 2 years of age were allocated in a completely randomized design. The animals were housed individually in digestibility cages measuring 1.5m long; 0.5m wide and 1.6m high, equipped with a feeder, a drinking trough, a urine and feces collecting device following a completely randomized design (Figure 1).

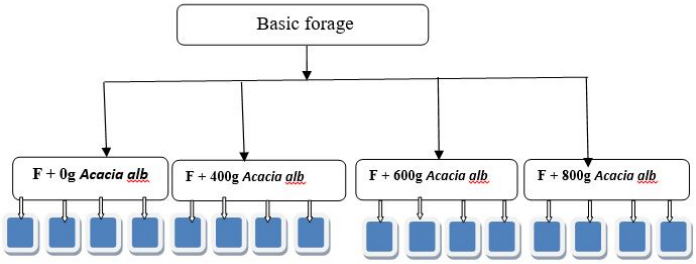

Figure 1: Experimental design

The experiment was preceded by an adaptation period of 14 days to allow the animals to become familiar with the rations and the confinement and 7 days of data collection. Each group was fed exclusively with one of the four rations. Water was provided ad libitum.

The different rations were offered two (2) times a day (8:00 am and 3:00 pm). Every morning, the refusals and feces produced by each animal were collected and weighed using an electronic scale with a capacity of 3000g and a sensitivity of 1g. A 100g sample of feces from each animal was then collected and dried at 60°C to constant weight in a ventilated oven for chemical composition analysis. Similarly, the urine produced by each animal was collected in containers in which sulphuric acid (H2SO4) diluted to 10% was previously introduced according to the average volume of urine produced by each animal during the adaptation period. This was done in order to stabilize the urinary nitrogen. The volume of urine collected each morning was measured in a 500ml graduated cylinder. A 10ml sample was then taken and put into vials, stored at 4°C in a refrigerator for nitrogen analysis. The data collected were used to calculate the apparent digestive utilization coefficients (aDUC) of dry matter (DM), organic matter (OM), Crude Protein (CP), Crude Fiber (CF) and nitrogen, according to the formulas described by Roberge and Toutain [8]:

$$\text{aDUC DM}(\%) = \frac{\text{D Mingested} - \text{DMexcreted}}{\text{D Mingested}} \text{x100}$$

$$\text{aDUC OM}(\%) = \frac{\text{O Mingested} - \text{O Mexcreted}}{\text{OMingested}} \text{x100}$$

$$aDUC\ CP(\%) = \frac{\text{CP ingested} - \text{CP excreted}}{\text{CP ingested}} \times 100$$

$$aDUC\ CF(\%) = \frac{\text{CF ingested} - \text{CF excreted}}{\text{CF ingested}} \times 100$$

Data Analysis

The data collected were subjected to a one-factor analysis of variance (feed intake) in a completely randomized design. When there were significant differences between treatments, Duncan's test was applied to separate the means at the 5% significance level [9]. The statistical software SPSS 20.0 (Statistical Package for Social Sciences) was used for these analyses, following the general linear model.

Results

Effect of *Acacia albida* Leaf Supplementation on Feed intake of Ewes

The intake of *Acacia albida* leaves, dominant rangeland forages and total nutrients by ewes is presented in Table 1. From this table, it appears that acacia leaf supplementation significantly ($p<0.05$) influenced the intake of dominant forages, Dry Matter (DM), Organic Matter (OM), Crude Protein (CP) and crude Fiber (CF) in Arab ewes. Indeed, increasing addition of the supplement in the ration allowed an increasing intake of the different nutrients as well as of the dominant forages.

Table 1: *Acacia albida* leaf supplementation on feed intake in ewes

Feed intake (g DM/d/animal)	Group1	Group 2	Group 3	Group 4	p
Acacia albida	/	400±0.00^{c}	600±0.00^{b}	800±0.00^{a}	0.001
Dominant forage on rangeland					
Dactyloctenium aegyptium	205.73±4.05^{d}	220.70±4.50^{c}	231.54±2.10^{b}	237.21±3.11^{a}	0.001
Cenchrus ciliaris	205.72±4.08^{d}	220.90±5.31^{c}	231.34±2.16^{b}	237.40±3.10^{a}	0.001
Panicum maximum	411.45±8.50^{d}	441.50±9.40^{c}	462.88±5.13^{b}	474.61±6.10^{a}	0.001
Total forage intake	822.90±16.63^{d}	883.20±19.21^{c}	925.76±9.39^{b}	949.22±1231^{a}	0.001
Total food ingested					
Dry matter	1124.25±220.42^{d}	1394.47±129.81^{c}	1613.12±106.91^{b}	1824.25±220.42^{a}	0.001
Organic matter	1045.72±205.13^{d}	1297.21±120.7^{c}	1500.70±99.50^{b}	1845.72±205.13^{a}	0.001
Crude protein	296.78±26.43^{d}	454.12±65.84^{c}	580.32±62.75^{b}	696.78±26.43^{a}	0.001

Crude fiber	359.55±56.17[d]	427.90±34.90[c]	583.45±26.96[b]	659.55±56.17[a]	0.001

a, b, c and d: Values assigned the same letter on the same line do not differ significantly (p>0.05). Group 1= dominant forage in the pasture without *Acacia albida*; Group 2= dominant forage in the pasture + 400g *Acacia albida*; Group 3= dominant forage in the pasture + 600g *Acacia albida*; Group 4= dominant forage in the pasture + 800g *Acacia albida*; p = Probability.

Effect of *Acacia albida* Leaf Supplementation on Digestive Nutrient Utilization in Ewes

The digestibility of dry matter, organic matter, crude protein and crude fiber of the dominant forages of natural pasture supplemented with *Acacia albida* leaves in ewes is presented in Table 2. It shows that the addition of the supplement significantly (p<0.05) influenced the digestibility of the different nutrients in Arab ewes. Indeed, the digestibilities of dry matter, organic matter, crude protein and crude fiber of the supplemented groups were comparable (p>0.05) to each other and significantly higher (p<0.05) than the control group.

Table 2: *Acacia albida* leaf supplementation on digestive nutrient utilization in ewes

aDUC (%)	Group1	Group2	Group3	Group4	p
Dry matter	61.21±3.82[b]	80.91±2.40[a]	79.50±1.89[a]	79.24±3.94[a]	0.001
Organic matter	65.97±3.37[b]	83.35±2.14[a]	82.35±2.00[a]	83.05±3.22[a]	0.001
Crude protein	66.50±2.53[b]	83.47±4.41[a]	80.78±6.59[a]	82.94±3.85[a]	0.001
Crude fiber	47.82±5.16[b]	81.96±2.35[a]	78.59±2.41[a]	79.39±3.93[a]	0.001

a and b: Values assigned the same letter on the same line do not differ significantly (p>0.05). Group 1= dominant forage in the pasture without *Acacia albida*; Group 2= dominant forage in the pasture + 400g *Acacia albida*; Group 3= dominant forage in the pasture + 600g *Acacia albida*; Group 4= dominant forage in the pasture + 800g *Acacia albida*; P= Probability.

Effect of *Acacia albida* Leaf Supplementation on Nitrogen intake and Digestive Utilization in Ewes

The digestive nitrogen utilization of dominant forages of natural pasture supplemented with *Acacia albida* leaves in Arab ewes is presented in Table 3. It shows that nitrogen intake decreased significantly (p<0.05) with increasing supplementation in different groups. In contrast, the addition of the supplement in the different lots had no significant effect on fecal nitrogen, urinary nitrogen, retained nitrogen, and nitrogen digestibility.

Table 3: *Acacia albida* leaf supplementation on nitrogen intake and digestive utilization in ewes

Nitrogen balance (g/d)	Group1	Group2	Group3	Group4	p
Ingested nitrogen	12.16±0.24[a]	11.33±0.24[b]	10.80±0.10[c]	10.54±0.13[c]	0.001
Fecal nitrogen	5.54±0.71[a]	5.77±0.38[a]	4.73±1.28[a]	4.47±0.22[a]	0.099
Urinary nitrogen	3.48±0.19[a]	3.44±0.15[a]	3.26±0.28[a]	3.49±0.33[a]	0.549
Nitrogen retained	3.14±0.38[a]	2.13±0.38[a]	2.82±1.21[a]	2.57±0.56[a]	0.291
aDUC (%) N	25.85±3.40[a]	18.73±3.08[a]	26.08±11.15[a]	24.37±5.10[a]	0.386

a, b and c: Values assigned the same letter on the same line do not differ significantly (p>0.05). Group 1= dominant forage in the pasture without *Acacia albida*; Group 2= dominant forage in the pasture + 400g *Acacia albida*; Group 3= dominant forage in the pasture + 600g *Acacia albida*; Group 4= dominant forage in the pasture + 800g *Acacia albida*; P = Probability

Discussion

The good association of source of energy and protein sources in good proportion can improve is ruminant the feed intake and digestibility. Thus feed intake of a ration is a ration-specific characteristic that reflects its ability to be voluntarily ingested in greater or lesser amounts [10]. It varies with the palatability of the feed rations. From results of this work, it is apparent that intake of dominant forages increased with *Acacia albida* leaf supplementation. Indeed, the optimal level of supplementation of a poor forage resource with another forage of better quality should maintain or even increase the intake of the basic ration instead of increasing the substitution rate of the latter by the supplement. This substitution phenomenon has been observed very often in animals receiving legume forage supplements with different rates of degradation in the rumen [11, 12]. Similarly, according to many authors, protein supplements would promote sufficient proliferation of gut microorganisms involved in digestion in herbivores [13, 14, 16]). This would promote increased food fermentation and transit with consequent increase in food intake. The digestive use of food or digestibility is the degree of use of feed or nutrients from this food [17]. According to this author, it is a quantitative concept that is translated by the coefficient of digestive use (C.D.U) or coefficient of digestibility (C.D.). This data refers to the proportion of the various constituents of food that is retained by the body (Lhoste et al., [18] cited Miégoué et al., [19]). In the present study, supplementation with *Acacia albida* leaves resulted in significant digestive utilization of crude protein. This study thus showed that an association of dominant forages of natural pasture, with *Acacia albida* leaves can be used as an alternative protein source with good results. This is in agreement with the work of Pamo *et al.* [20] on with the Guinea dwarf goat, who reported that improving forage utilization through supplementation with *Calliandra calothyrsus* is not only economical but also allows the animal to make better use of basic forages, thus ensuring coverage of nutritional needs. The digestibility of dry matter, organic matter, crude protein and crude cellulose was significantly higher with the addition of 400g of supplement. Similarly, the significantly higher values of dry matter, organic matter, crude protein and crude fiber digestibility were obtained with the supplemented rations. The high aDUC of these nutrients could be explained by the addition of *Acacia albida* leaves in the supplemented lots compared to the control group. Indeed, even a small increase in nitrogen supply improves the digestibility of nutrients in general and fiber in particular. In fact, the high protein content in *Acacia albida* leaves creates favorable conditions in the digestive tract for the proliferation of microflora, which then would have accelerated the fermentation processes, thus causing a consequent and/or concomitant improvement in nutrient digestibility.

Supplementation had no significant effect on fecal nitrogen, urinary nitrogen, retained nitrogen, or nitrogen digestibility. In contrast, nitrogen intake decreased significantly with increasing supplementation. These results seem to attest that, the association of *Acacia albida* leaves in the ration, limits the ingestion of nitrogen. This phenomenon would be responsible for an increase in ammonia production in the rumen, which would cause the release of nitrogen by the animal organism. The association of *Acacia albida* leaves in the ration has contribute to the improvement of the feed intake and the digestibility.

Conclusion

Evaluation of *in vivo* intake and digestibility of dominant forages of natural pasture supplemented with *Acacia albida* leaves in Chadian Arab ewes showed that the supplement improved intake of dominant forages of natural pasture as well as intake of dry matter, organic matter, crude protein and crude fiber. Similarly, the addition of the supplement significantly improved the digestibility of dry matter, organic matter, crude protein and crude fiber of the dominant forages of natural pasture in Arab ewes. On the other hand, the best digestive utilization of DM, OM and CF was obtained in the groups receiving 400g of *Acacia albida* leaves.

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