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In Vivo Digestibility of *Brachiaria deflexa* and *Echinocloa colona* Supplemented with Cowpea Haulms in Sahelian Goats

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Abstract: A study of In vivo digestibility of *Brachiaria deflexa* and *Echinocloa colona* fed Sahelian bucks supplemented with 30% cowpea haulms was conducted in the Scientific Garden of the University of Sciences and Technology of Ati in Chad by September 2018. Twelve (12) Sahelian bucks weighing around 28. 62 ±2. 97 kg, aged between 20 and 24 months were used for this feeding trial. Four (4) groups of three (3) animals were housed in individual metabolic cages, where they were treated with Oxytetracycline 20% long-acting (1ml/10 kg) and 1% of Ivermectin against gastrointestinal and pulmonary worms before trials. Four rations were made and distributed hazardly to each group as follows: *Brachiaria deflexa* without supplement of cowpea haulms (BF_0), *Brachiaria deflexa* suplemented with 30% cowpea haulms (BF_{30}), *Echinocloa colona* without suplement (EF_0) and *Echinocloa colona* suplmented with 30% cowpea haulms (EF_{30}). Each animal received 1000g of feeds twice a day for basal feeds during the adaptation period (14 days). After this period, data were collected for seven (7) days. The result shows that *Echinocloa colona* supplemented with 30% cowpea haulm induced a significant ($p<0.05$) intake of DM (697.2g), OM (525.14g), and CF (214.35g) in Sahelian bucks. While, digestive utilization of these elements was comparable ($p> 0.05$). Though, digestive utilization of nitrogen (58.68g) was significantly ($P<0.05$) high in bucks. Biochemically, blood concentration with protein elements (protein, albumin, and globulin) was similar in bucks fed *Brachiaria deflexa* or *Echinocloa colona* alone or associated with 30% cowpea haulms. As such, bucks could be fed with dried forage without cowpea supplements to minimize production costs.

Keywords: Digestibility, *Brachiaria deflexa* and *Echinocloa colona*, Supplement, Sahelian Bucks

1. Introduction

In sahelian zone, climatic alias affects negatively forage biomasses and drinking possibility of livestock [9]. In this region, small ruminant production is one of the valuable social activities that guarantee the population's life [14]. Goats are the most bred species of small ruminants in urban and periurban areas [6]. These animals produce milk to feed malnourished infants, feces as farm fertilizer [14], and meat for socioeconomic equilibrium and cultural activities of the population [6, 14]. Nowadays, demographic pressure over pasture resources decreases considerably grazing spaces, hence, causing social conflicts between breeders and farmers [17]. Tough, satisfaction of nutrients needs for ruminants is never achieved in a dry season [6, 17]. To improve the problem of nutritional deficiencies, supplementation of poor forages seems as an alternative for better feeding in a dry season [30]. Crop residues, like cowpea haulms with a high level of nitrogen, are available in a dry season [6], it could be used as the best mean of ruminant supplementation [1, 6]. In fact, feed conversion into proteins depends on the ability of forage to release its nutritive substances into the blood for the different synthesis of products. For rational utilization of forages, the effects of cowpea haulm supplementation on biochemical parameters need to be studied, especially for energy and protein elements. This study aims to improve animal production in Sahelian regions. Mainly, it is focused on the study of:

1) chemical composition of some forages of pasture;
2) effect of cowpea haulms supplementation on intake and in vivo digestibility of *Brachiaria deflexa* et *Echinocloa colona* in Sahelian bucks;
3) effect of cowpea haulm supplementation on biochemical parameters in sahelian bucks.

2. Materials and Methods

2.1. Area of Study

This study was carried out in a Scientific Garden of the University of Sciences and Technology of Ati (JSUSTA), district of Ati in the province of Batha in Chad (Figure 1). Extended between 13°12'30" and 13°14'00" North latitude and 18°19'00" and 18°21'00" East longitude, Ati city is located in the center of the country, with a surface area of 21 km^2 [19]. The rainy season goes from June to September, with annual precipitation ranging from 200 mm to 500 mm in three months; while the dry season starts from October to May with atmospheric temperatures between 14^{oC} and 42^{oC}. The relief is slightly uneven, with temporary streams of water. Soil types are sandy to compact clay loamy in the north. They are large dune silts and trays with closed depressions kwon as "oasis" sometimes very close, with vegetation of the Sahelian type [6, 8]. Livestock and crop production are the main activities of the populations.

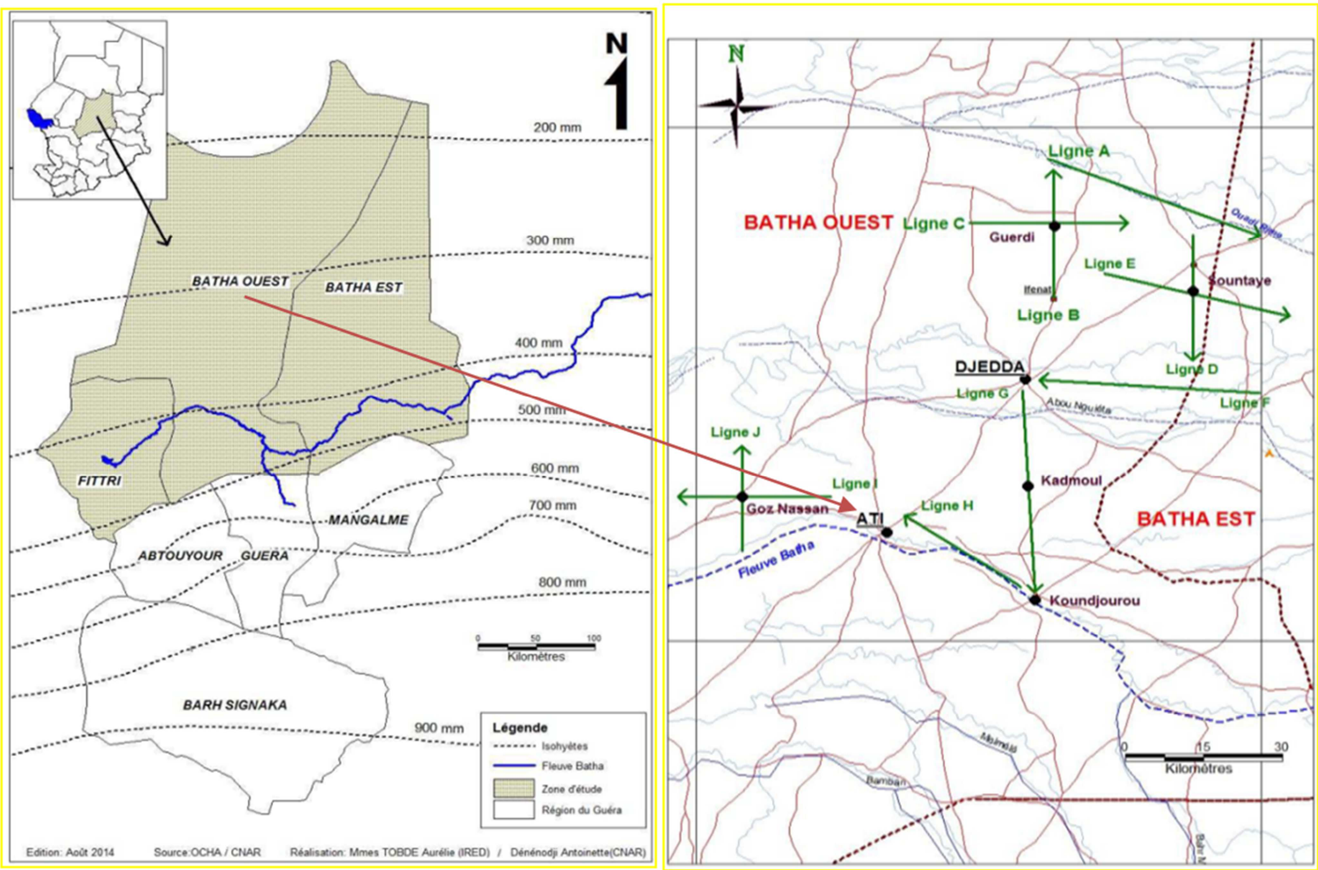

Figure 1. *Location of Ati in the map of the province of Batha, in Tchad [8].*

2.2. Animals and Health Protection

Twelve (12) Sahelian bucks aged between 20 and 24 months were purchased in the local market and weighed (28. 62±2. 97 kg) for this trial. Their ages were determined by the method described by Corcy [10]. Preventive treatment was administered to each animal according to health methods described by Mubi *et al.* [20]. Each animal receives Oxytetracycline 20% long-acting (1ml/10 kg) and dewormed with Ivermectin 1% against gastrointestinal and pulmonary worms before trials. They were also numbered with ear loops and were submitted to experimental forages for 14 days for acclimatization.

2.3. Forages and Feeds Formulation

Being the major forages of peri-urban pasture of Ati [6, 8], *Brachiaria deflexa* and *Echinocola colona* was harvested in august according to the procedures described by Theau *et al.* [28]. Harvested biomass was sundried under the shade at ambient temperature. Supplement (cowpea haulm) was purchased from local farmers for feeding trials. Four (4) treatments (diets) were made from *Brachiaria deflexa* and *Echinocola colona* associated or not to cowpea haulm for in vivo digestibility test with bucks as follow:

1) T1: *Brachiaria deflexa* without supplement of cowpea haulms (BF_0);
2) T2: *Brachiaria deflexa* supplemented with 30% cowpea haulms (BF_{30}).
3) T3: *Echinocloa colona* without supplement of cowpea haulms (EF_0);
4) T4: *Echinocloa colona* supplemented with 30% cowpea haulms (EF_{30}).

Feeds were hazardly attributed to animal groups in the metabolic cages.

2.4. Experimental Design

Twelve (12) bucks with an average weight of 28.62±2.97 kg were distributed into the metabolic cages in four groups (4) in a completely randomized design (Figure 2). The cages were equipped with feeders and drinkers. Four groups of three (3) animals were made for feeding trials with forages, either associated or not with cowpea haulms. Each animal was weighed at the beginning of study and the end, after 14 days of adaptation to feeds and the claustration.

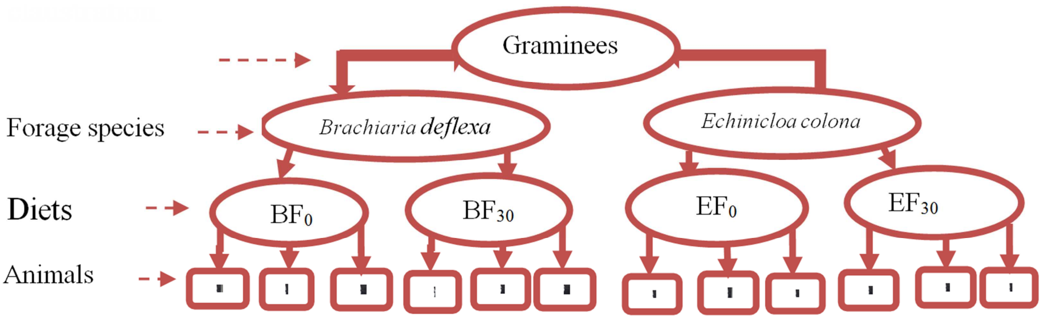

***Figure 2.** Experimental design for feeds digestibility trials.*

2.5. Feeds Intake and in Vivo Digestibility

2.5.1. Feed Intake

During feed intake and digestibility evaluation study, a thousand grams (1000g) of feeds were offered to animals daily in two periods at 8 o'clock Am and around 2 o'clock Pm for basal feeds. While for experimental diets, it was given in addition to basal feeds, 30% of cowpea haulms. A weighing scale carrying 3 kg maximum and 1g of sensitivity was used. While animals were weighed using 100 kg scales with 50g sensitivity. The excreted urine of each animal was collected and measured every morning with a 500 ml graduated cylinder, and 100g of diets and feces were sampled for chemical analysis. Likewise, 100 ml of urine was collected in 125 ml beakers where 10 ml of sulfuric acid (H_2SO_4) was added for nitrogen stabilization. A sample of 10 ml was collected into the tubes and stored at 4°c in a refrigerator for residual nitrogen determination. Feed intakes were obtained by the difference made between feeds offered and the leftover the next day as shown in the following formula.

$$\text{Intake} = \text{Feed day N} - \text{Left over N+1}$$

2.5.2. In Vivo Digestibility

Chemical analysis of forages and feces, and residual determination of nitrogen from urine enabled the determination of chemical components utilization of forages in Buck. Therefore, the apparent digestibility coefficients (CUDa) of DM, OM, and CF were determined using the formula described by Roberge and Toutain [23].

$$\text{CUDa X (\%)} = (\text{X ingested} - \text{X excreted}) / (\text{X ingested}) \times 100$$

Though, the digestibility of organic matter (dMO), crude protein (CP), and carbohydrates of feeds were determined using the methods described by AOAC [4]. Indeed, gross energy (GE), energy for milk (UFL), and meat production (UFV) were calculated using Sauvant [24] and Van Soest, [32] procedures.

2.5.3. Chemical Composition

Feed constituents were analyzed in Institute for Agronomic Research for Development (ITRAD) and at the Food Quality Control Center of N'djamena (CECOQDA) laboratory in Chad Samples of diets, feces, and feeds supplement (100g) were oven-dried at 60°C for 48 hours to obtain constant weight. Samples were ground to the size of 1 mm using a tri-hammer mill. Dry matter (DM), ash, crude protein (CP), and crude fiber (CF) concentration of feeds were analyzed using Kjeldahl Weende [4], Van Soest and Robertson [31] methods.

2.5.4. Blood Profiles

Blood samples were collected from jugular vena of each animal in test tubes during a week for determination of energy and protein parameters in blood serum. After collection, serum samples were centrifuged (3500 runs) for 3 min. the obtained overflow was collected in dried. Analyses were carried out according to the method described by Skeggs and Hochstrasser [25], and Audege *et al*. [2].

2.6. Statistic Analyses

Feeds intake and *in vivo* digestibility data were subjected to two ways analysis of variance (animal and diets), following a general linear model in a completely randomized design. The means were separated by Duncan's multiple range tests, when there were significant differences at 5%. SPSS 20.0 software was used for statistical Analysis with the following model [26].

$$Yij = \mu + \alpha ij + \beta ij + eij$$

where

Yij = observation on the animal j that received the rations i,
μ = General average,
αi = effect of the ration i,
βj = effect of the ration j,
eij = residual error on animal j that received ration i.

3. Results and Discussion

3.1. Chemical Composition

A study of chemical composition of forages (Table 1) shows that dry matter of *Brachiaria deflexa* (94. 21%), *Echinocloa colona* (92. 92%) and cowpea haulms (95%) were relatively closer. The crude fiber (CB) level of *B. deflexa* (36. 98%) was greater than that of *E. colona* (31.27%) and cowpea haulms (26. 9%). The organic matter of cowpea haulms (90. 27%) was greater than that of *B. deflexa* (87.54%) and *E. colona* 80.17%). Fat content was lower in both forage species. Though, mineral concentration in *E. colona* (12, 75) and cowpea haulms (9. 71) was more elevated in *Brachiaria deflexa* (7. 67%). Nitrogen concentration was higher in cowpea haulms (10. 60) than in *B. deflexa* (6.50%) and *E. colona* (4.80%).

Table 1. *Chemical composition of forages.*

Fourrages			
Paramètres	***B. deflexa***	***E. colona***	**Fanes de niébé**
Dry Matter (%)	94.21	92.92	95.25
Crude Fiber (%MS)	36.98	31.27	26.90
OM (%MS)	92.33	87.25	90.29
Lipid (%MS)	1.27	1.00	1.40
Ash (%MS)	7.67	12.75	9.71
Nitrogen (%MS)	6.50	4.80	10.60
Digestibility of OM (%DM)	85.68	85.39	56.49
Carbohydrate (% DM)	75.08	61.71	75.48
Digestible CP (g/1000g OM)	20.44	17.5	26.42
UFL /kg DM	0.60	0.71	0.79
UFV/kg DM	0.47	0.59	0.83

Where: DM: dry matter; OM: organic matter; CF: crude fiber; OM: organic matter digestibility; CP: crude protein; UFL: energy for milk production; UFV: energy for meat production

However, the digestibility of *B. deflexa* (92. 33%) and *E. colona* (87.25%) were lower than those of cowpea haulms (90. 29%). Likewise, carbohydrate levels were relatively higher in cowpea haulms (75. 48%) and *B. deflexa* (75. 08%) than in *E. colona* (61. 71%). The same observation was made with degradable nitrogen in cowpea haulms (26.42g), *B. deflexa* (20.44g), and *E. colona* (18.40g). Though, the energies for milk (UFL, 0.76) and for meat (UFV, 0.79) were relatively higher in cowpea haulms and *E. colona* (0.71; 0.59) than in *B. deflexa* (0.60; 0.47).

3.1.1. Feeds Intake

The Dry matter, the organic matter, and crude fiber of *B. deflexa* associated with 30% of cowpea haulms had a similar ($p<0.05$) effect in Sahelian bucks (Table 2). However, *E. colona* associated with 30% of cowpea haulms has significantly ($p<0.05$) increased intake of DM, MO, and CF in Sahelian goats.

Table 2. *Dry mater, Organic matter, and crude fiber intake of B. deflexa and d'E. colona supplemented with 30% of cowpea haulms in bucks.*

Fourrages	Diets				
	Feeds intake	**$F+CH_0$**	**$F+CH_{30}$**	**SEM**	***P***
B. deflexa	DM	612.1	606.55	19.7	0.875
	OM	503.6	498.15	16.21	0.875
	CF	213.27	210.96	6.86	0.875
E. colona	DM	528.76^b	697.2^a	23.26	0.022
	OM	398.26^b	525.14^a	17.52	0.022
	CF	153.64^b	214.35^a	3.33	0.001

a, b: Means carrying different letters on the same line are significant ($p<0.05$) at 5%, $F+CH_0$: forage without supplement; $F+CH_{30}$: forage + 30% of cowpea haulms; SEM: standard Error of Mean; P: Probability

3.1.2. In Vivo Digestibility of Brachiaria deflexa and Echinocloa colona Associated with 30% of Cowpea Haulms

A supplementation of *B. deflexa* and *E. colona* with 30% of cowpea haulms had a comparable (p>0. 05) effect on the digestibility of DM, OM and CF when fed to bucks, with all forages (Table 3).

Table 3. *Digestibility of B. deflexa and E. colona supplemented with 30% of cowpea haulms in sahelian bucks.*

Forages	Apparent Digestibility	Diets		SEM	*P*
		$F+CH_0$	$F+CH_{30}$		
	DM	60.52	68.64	2.08	0.122
B. deflexa	OM	57.64	60.77	1.50	0.358
	CF	71.73	71.26	1.10	0.841
	DM	64.68	60.08	2.44	0.399
E. colona	OM	61.72	56.27	2.50	0.336
	CF	65.97	67.44	1.34	0.614

Where: F+ CH_0: Forage without complement; forage $+CH_{30}$: forage + 30% of cowpea haulms; SEM: standard Error of mean; P: Probability; ESM: standard Error of mean; P: Probability

3.1.3. Nitrogen Balance of B. deflexa and E. colona Associated with 30% of Cowpea Haulms in Goats

The intake of *B. deflexa* associated with 30% of cowpea haulms had a comparable (p>0.05) effect on nitrogen balance in Sahelian bucks (Table 4).

Table 4. *Nitrogen utilization of Brachiaria deflexa and Echinocloa colona associated with 30% cowpea haulms in Sahelian bucks.*

Fourrages	Nitrogen balance	Experimental diets			
		$F+CH_0$	$F+CH_{30}$	SEM	*p*
	N intake	5.13	5.07	0.16	0.873
	Fecal N	1.53	1.40	0.10	0.544
B. deflexa	N from urine	1.79	2.51	0.28	0.22
	N retained	1.78	1.18	0.35	0.374
	CUDa nitrogen	72.18	51.14	6.19	0.165
	N intake	3.05^b	4.02^a	0.13	0.022
	N feces	1.18^b	2.05^a	0.16	0.042
E. colona	N from urine	0.42^b	1.25^a	0.03	0.001
	N retained	1.36	0.67	0.17	0.126
	CUDa nitrogen	37.76^b	58.68^a	6.19	0.001

a, b: means carrying different letters on same line are significant at the level of %. F + CH_0: forage without supplement; $F+CH_{30}$: forage + 30% of nitrogen; SEM: standard Error of mean; P= Probability

Contrary, *E. colona* associated with 30% cowpea haulm have a significantly (p<0.05) increased feed intake, fecal and urine excretion as well as digestive utilization de nitrogen in bucks.

3.1.4. Biochemical Parameters in Sahelian Bucks

Protein and energy concentration parameters in bucks fed with *Brachiaria defelexa* and *Echinocloa colona* alone or associated with 30% of cowpea haulms before and after feeding are resumed in table 5.

Table 5. *Rate of blood protein, albumin, and globulin in Sahelian bucks fed B. deflexa et E. colona alone or complemented with cowpea haulms.*

Period	Rations	Blood sugar (g/l)	Cholestrol (g/l)	Total Proten totale (g/l)	Albumin (g/l)	Globulin (g/l)
Before	BD_0	0.75±0.10	0.77±0.21	49.24±7.75	36.55±1.39	12.70±3.00
After	BD_0	0.69±0.02	0.71±0.03	50.02±0.19	29.94±3.94	20.09±3.86
Before	BF_{30}	0.66±0.04	0.75±0.21	69.50±7.91	36.77±4.97	46.07±11.80
After	BF_{30}	0.69±0.08	0.87±0.11	69.57±7.68	36.37±2.02	33.19±5.65
Before	EC_0	0.16±0.00	0.38±0.03	90.40±13.49	46.97±19.16	53.43±17.80
After	EC_0	0.17±0.03	0.46±0.10	101.05±17.45	59.34±4.83	41.70±13.52
Before	EF_{30}	0.18±0.01	0.22±0.18	93.52±0.65	64.67±3.55	28.83±3.00
After	EF_{30}	0.25±0.03	0.24±13.64	92.36±28.04	63.42±2.15	28.82±26.51

Where: BD0= *Brachiaria deflexa* without supplements; BFN30= *Brachiaria deflexa* supplemented with 30% cowpea haulms; EC_0= *Echinocloa colona* without supplements; EFN_{30}= *Echinocloa colona* complemented with 30% cowpea haulms.

This table shows that, *B. deflexa* and *E. colona*, complemented or not, do not influence energetic concentration elements (glucose et cholesterol) in bucks before and feeding. Likewise, protein concentration elements (protein, albumin and globulin) was comparable (p>0. 05) in bucks independent of feeds and feeding periods. Although, *B. deflexa* and *Echinocloa colona* fed alone or associated to 30% of cowpea haulms to Sahelian bucks had a similar effect (p>0. 05) on blood parameters independent to the period of blood sampling.

3.2. Discussion

Echinocloa colona associated with 30% of cowpea haulms increased significantly ($p<0.05$) its chemical components intakes in bucks. The intake of this forage was higher than that reported by Idrissou *et al* [16] in bucks fed with *Panicum maximum* supplemented with *Leucaena leucocephala* (358.74g + 311.52g) leaves. The same observation was made by Pamo *et al* [21] in nain Guinee Goat (700g and 800g) when they were grazed on main tropical forages (*Brachiaria ruziziensis, Pennisetum purpureum,* and *Trypsacum laxum*) supplemented leguminous leaves (*Leucaena leucocephala* and *Calliandra calothyrsus*). Though, Pamo *et al*. [22] stipulated that a supplement with a high level of nitrogen increases the intake of poor forages with high-level crude fibers. This is favored by the association of nitrogen from cowpea haulms that could have favored the proliferation of microorganisms hence, degraded forages and utilized nutrients by animals.

Feeds supplementation with cowpea haulm had a similar ($p>0.05$) effect on the digestion of chemical components of *B. deflexa* and *Echinocloa colona* in bucks with experimental feeds. Only crude fiber of *B. deflexa* was significantly (p<0. 05) digested by Sahelian bucks. This could be explained by the level of dry matter in which the proportion of leaves of cowpea could have induced a greater digestibility of nitrogen. When forges were associated with 30% of cowpea haulm, feed intake, fecal excretion as well as digestive utilization of nitrogen from *E. colona* were significantly (p<0. 05) greater than that from *B. deflexa*. This is similar to the assertion of Azoutane *et al*. [5] who stipulated that nitrogen from cowpea haulm enhances the microbial synthesis of protein, the degradation and digestive utilization of tropical forages in small ruminants. Although, a significant ($p<0.05$) excretion of nitrogen through urine from *E. colona* probably impacted negatively its retentions in bucks. This coincides with the assertions of Chenost, [11] and Allouche, [3] who stipulated that the loss of nitrogen through feces could be linked to indigestible nitrogen that was expelled through fibers in feces. Though, some authors [29] showed that goats are adapted to arid regions and they can convert poor forages into animal protein. Therefore, a similar effect of *B. deflexa* supplemented with cowpea haulm on nitrogen balance in Sahelian bucks, could be linked with excessive accumulation of nitrogen from cowpea haulms (10. 60%) that could have affected the pH of the rumen. This result agreed with the observation some authors [13, 27] who reported that, addition of supplements and nitrogen fermentation in the rumen increase the excretion flow of digested elements in small ruminants.

Concerning blood parameters, the metabolic concentration in the blood comes from digestion of feeds consumed by the animals. The capacity of nitrogen and energy metabolism to fulfill the needs of ruminants depends to microbial digestion [18]. Though, the more feed is digestible, the more animal receives nutrients for body building and various productions. In this situation, when feeds were served to animals, no significant ($p>0.05$) difference was observed with glucoses and protein concentration for the bucks fed *B. deflexa* and *E. cholona* alone or associated with 30% of cowpea haulms before and after feeding. A similar concentration in energies and plastics parameters in blood could be linked to the availability of nitrogen derived from feed degradable protein and microbial corps in the rumen [12, 15], with the same effect compared to the experimental diet. Because, low digestibility of diets leads to the west of nutrients (energy and protein) via urine methane production [7, 18].

4. Conclusion

A supplementation of forages with 30% of cowpea haulms has a significant ($p<0.05$) effect on the chemical component's intake of *E. colona* in bucks. Although, goats could be fed qualitative dried *Brachiaria deflexa* stored in good condition without any parasites. Supplementation of this forage had a similar effect on intake. The same observation was made on the digestive utilization of chemical components of these forages in Sahelian bucks. Though, digestive utilization of *E. colona* components had a significantly (p<0. 05) higher effect in bucks. Then dried *E. colona* alone cannot enhance fast fattening of bucks at this phonologic stage of grass. The utilization of cowpea haulms is then a means for boosting meat production in the dry season in the Sahelian zone.

Metabolite synthesis being under hormonal and availability of energy substrates enhanced the regulation of biochemical parameters in bucks. Though, metabolite synthesis and proteolysis are simultaneous phenomenon [3]. Also, if protein synthesis is higher than proteolysis, there is a net increase in protein gain; in order way, high proteolysis over synthesis will lead to a decrease in protein volume. In this study, a similar effect of *B. deflexa* and *E. colona* associated with 30% of cowpea haulm on serum energies and proteins elements could be due to the fact that, feeds are never completely digested, and this situation leads to the west of nitrogen and energy through urine and production of methane [7, 18].

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