EVALUATION OF THE COMPARATIVE GROWTH AND REPRODCUTIVE PERFORMANCE OF WEST AFRICAN DWARF GOATS IN THE WESTERN HIGHLANDS OF CAMEROON

E. TEDONKENG PAMO, F. TENDONKENG, J.T.T. KADJIO,
H.N. KWAMI, R.K. TABOUM, J.R. KANA, A. TEGODJEU
University of Dschang, FASA,
Department of Animal Sciences,
Dschang, Cameroon

Abstract

EVALUATION OF THE COMPARATIVE GROWTH AND REPRODCUTIVE PERFORMANCE OF WEST AFRICAN DWARF GOATS IN THE WESTERN HIGHLANDS OF CAMEROON.

On-farm and on-station evaluations of the comparative growth performance of West African Dwarf Goats supplemented at an iso-nitrogenous level (6 g/animal/day) with leguminous browse *Calliandra calothyrsus, Leucaena leucocephala,* or *Gliricidia sepium,* or with cotton seed cake, were conducted around Dschang in the Western Highlands of Cameroon and at the University Experimental Farm. The animals were weighed every 21 days during the rainy season and every 14 days during the dry season for three months to evaluate their response to supplementation. Cotton seed cake, *L. leucocephala, C. calothyrsus* were the most accepted supplements. The weight gain of the animals fed with these supplements was significantly higher compared to that of the control animals. Mean weight of animals supplemented with *G.sepium* was not significantly different (P >0.05) from that of the control group during the rainy season. The average daily weight gains during the rainy period were 20.6, 19.1, 13.8, 4.5, and 3.1 g for *L. leucocephala*, cotton seed cake, *C. calothyrsus*, *G. sepium* and the control animals respectively, during the rainy season and 19.9, 16.1 and 1.7 g for cotton seed cake, *L. leucocephala* and the control animal respectively, during the dry season. Progesterone profiles were low and were unaffected by supplementation during the dry season.

1. INTRODUCTION

In many areas of Africa, ruminant livestock production has long been of major importance to the rural population. It has served many purposes: in the direct production of food, providing traction for transportation and land preparation, as a cash reserve for emergency investments and long term saving, and in the fulfillment of social obligations. However, ruminant production across most of these areas is constrained by the poor quality of the consumed feed.

The alternating relatively long-dry and short-rainy seasons, as one moves from the south to the north of tropical areas, has a major influence on the productivity and quality of rangeland [1]. During the rainy season, range plants grow rapidly and although their quality may be good early in the season, they mature rapidly with a resulting decline in quality. Their decline in quality impairs the productivity of ruminant livestock that depend mainly on grassland [1]. Often, the crude protein content of range vegetation particularly during the dry season is less than the critical level of 6–7% needed to maintain an efficient rumen function [2]. The growth rate and milk production of ruminants grazing tropical pastures or consuming crop residues alone are generally low and represent only about 10% of the animal's genetic potential [3]. This low productivity is due mainly to poor nutrition which lowers the resistance of animals to infectious and parasitic diseases, leading to high mortality rates among young (30–40% in calves and 50% in lambs and kids) and low fecundity in adult females (60–66%) [4].

Under the traditional system of management of small ruminants, animals are allowed to graze and scavenge on household waste in or around the village during the dry season. During the rainy season with most of the land under crop production, animals depend on grass found along the roadside, on fallow land or where they are usually tethered, and on household waste. While this system entails little or no cost to the producer, it has adverse implications on the nutritional status, growth rate, reproductive performance and disease resistance of these animals. As a result, feeding has frequently been cited as the most limiting factor in ruminant production in tropical Africa. This is particularly true in highly populated rural areas such as the western region of Cameroon (density 400–1000 inhabitants/km^2) where most of what was left as rangeland is actually being used either for crop production or construction of buildings. The general tendency is a decline in animal production and small ruminant production in particular, while it has been estimated that during the next twenty years, world wide demand for meat will increase 2.5 times faster than the supply [4].

Increasing the efficiency of livestock production is therefore imperative. There is a need to increase animal production through higher out put per unit area of land. In the light of this, a shift from a resource-based to a more science-based system of livestock production has to play an increasingly important role in achieving these objectives. Furthermore, in the tropics small ruminants are not seasonal breeders [5]. Reproduction should normally occur all the year round. Unfortunately, that is not the case and often long anoestrus periods are observed, poor nutrition being a major cause. Poor feeding leads to problems amongst which, a reduction in growth, late sexual maturity, abortions, long post-partum anoestrus, and temporary or total fecundity are predominant. In general, very little or no information exists on these parameters for West African Dwarf Goats (WADG) in Cameroon. As a result, production and reproductive management of this species has been difficult.

In view of the above problems, a research programme on the improvement of production and reproductive performance of WADG was undertaken at the University of Dschang. The objective of this study was to evaluate the comparative growth and reproduction performance of WADG supplemented at an iso-nitrogenous level with 3 species of leguminous browse *Calliandra calothyrsus, Leucaena leucocephala or Gliricidia sepium* or with cotton seed cake, during the rainy and the dry seasons.

2. MATERIALS AND METHODS

2.1. Experiment I

2.1.1. Study area

The study was carried out in Foto, a village around Dschang in the Western Highland zone of Cameroon, and at the University Experimental Farm, during the rainy season. This area is located at an altitude of 1400 metres, and receives an annual rainfall of 1700–2000 mm. The climate of the region is of Sudano-Guinean type influenced by the altitude. The mean annual temperature is between 20–22°C. The region has one rainy season, which lasts from mid March to mid November and one dry season from mid November to mid March. The original vegetation of the region was of a shrub savannah type. However, the region has been transformed by years of intense crops production and the natural vegetation can only be occasionally observed.

2.1.2. Animals

The animals used for this study were West African Dwarf Goats (*Capra reversa*). Four groups of 11 goats each (8 to 12 months of age) were used in the on-farm studies. A

control group of 11 animals with similar characteristics was raised at the University Experimental Farm. The Study was conducted both on-farm and on-station concurrently, in order to speed up the adoption of the technique by the participating farmers. Furthermore, farmers were compensated if a feeding regime in the control group resulted in the death of any animals.

At the beginning of the trial all animals were vaccinated against goat plague (PPR). They received an antibiotic injection (long acting tetracycline) and underwent internal and external parasite control. In addition, all animals were regularly checked and treated for minor ailments as necessary.

2.1.3. Feeding

Animals were tethered every morning on fallow land or along the roadside where they stayed until night. They spent the night in the kitchen, the hangar, the veranda, or under the shade of the farmer's house. The major species of the pastures available to them during the day were: *Pennisetum purpureum, Pennisetum clandestinum, Brachiaria ruziziensis, Panicum maximum, Bidens spinosa, Titonia diversifolia, Chromolaena odorata, Sida spp., Setaria spp., Floribredum spp., Vernonia spp., Imperata cylindrica, Aspilia africa* and *Ageratum spp.*

Every morning 390, 513 or 380 g of fresh leaves of *L. leucocephala, G. sepium, or C. calothyrsus* respectively, corresponding to 6 g of nitrogen, were harvested from the University Experimental Farm and given to each animal of the corresponding treatment group. *G. sepium* just after harvesting or after keeping for one to two days, was distributed after soaking in a salt solution to improve its acceptability by the animal. Leaves of *C. calothyrsus* were offered just after harvesting. The fourth group, which was the cotton seed cake supplemented group, received 88.8 g of cotton seed cake per animal, corresponding to 6 g of nitrogen.

2.1.4. Data collection and statistical analysis

The entire study lasted for 84 days. After an adaptation period of 30 days, animals were weighed once every 3 weeks, early in the morning using a spring balance. Due to variation in initial weight, covariance analysis was carried out on the data and significant differences among adjusted treatment means were tested using the students '*t*' test [6].

2.2. Experiment II

2.2.1. Study area

This study was carried out during the dry season, between January and April 1999, at the University Experimental Farm. The station is located at an altitude of 1420 metres and receives an annual rainfall of 1700 to 2000 mm. The climate of the region is of Sudano-Guinean type influenced by the altitude. The mean annual temperature varied between a minimum of 10°C in July-August to a maximum of 25°C in February. The region has one rainy season, which lasts from mid March to mid November and one dry season from mid November to mid March.

2.2.2. Animals

Three groups of 6 goats each (1 to 2 years of age) and weighing between 7.7 kg and 14.3 kg, bought from different markets in the region, were divided into 3 groups. At the beginning of the trial all animals were vaccinated against goat plague (PPR). They received an

antibiotic injection (long acting tetracycline) and underwent internal and external parasite control. All animals were regularly checked and treated for minor ailments as necessary.

2.2.3. Feeding

The study started with an adaptation period of two weeks during which the animals in the two supplemented groups were fed their supplement *ad libitum*. During the trial period, the animals were released into the pasture every morning at 10 a.m. and were brought back to their stalls between 5 and 6 p.m.

Every morning prior to releasing the animals to pasture, 390 g of fresh leaves of *L. leucocephala* or 88.8 g of cotton seed cake, corresponding to 6 g of nitrogen, were given to each animal of the respective supplemental groups. Leaves of *L. leucocephala* were distributed just after harvesting. The animals in the control group received an *ad libitum* quantity of pasture-forage mixture in their stalls before 10 a.m.

The major forage species in the pastures where animals grazed were: *Pennisetum purpureum, Panicum maximum, Brachiaria ruziziensis, Bidens spinosa, Titonia diversifolia, Sida spp., Setaria spp., Floribredum spp., Vernonia spp., Aspilia africa* and *Ageratum spp. Trypsacum laxum* was regularly cut and distributed to the animals.

2.2.4. Data collection and statistical analysis

Animals were weighed in the morning once every 2 weeks, using a spring balance. Blood was collected every three days by jugular venipuncture during the 51-day experimental period to obtain the progesterone profile. The blood samples were processed in the laboratory and the serum was conserved in a deep freezer at –20°C until RIA for progesterone was carried out. The analytical method used was that proposed by FAO/IAEA [7]. Analysis of variance was carried out on the weighted data and significant differences among treatments means were tested using the student's '*t*' test [6].

3. RESULTS

3.1. Experiment I

3.1.1. Voluntary intake

The average quantities of fresh and dry matter of supplements and the quantity of nitrogen ingested by each animal are presented in Table I. *G. sepium* was the least preferred legume with an average consumption of 2.9% of the 149 g of dry matter offered. Some animals did not eat the forage during the whole experimental period. The consumption of *C. calothyrsus* and *L. leucocephala* were respectively, 78.2 and 78.3% of the dry matter offered. While the voluntary intake of *C. calothyrsus* was relatively constant (128.1 g), that of *L. leucocephala* increased from 59.7 g at the beginning of the study to 126.5 g at the end. In general, the animals could not consume the total quantity of leaves offered because the leaves easily mixed with the dirt in the soil. The animals in the cotton seed cake treatment consumed the total amount of supplement offered to them.

3.1.2. Growth and average daily weight gains

Table II shows the average mean weight of animals at different periods and for the different treatments. From this table it can be observed that there was a consistent increase in body weight of various magnitudes, during the study period. The animals supplemented with *C.*

calothyrsus, Cotton seed cake and *L. leucocephala* had an average weight at 42, 63 and 84 days significantly different (P <0.05) from that of the control group. However, the average body weight at each of the above periods was not significantly different between the supplemented groups. The mean body weight of animals supplemented with *G. sepium* was not significantly different from that of the control group.

The logarithmic adjustment of the weight with time in weeks produced the following equations :

C. calothyrsus $Y_C = 0.6228Ln(x) + 11.728$ ($R^2 = 0.79$)

L. leucocephala $Y_L = 0.4784Ln(x) + 12.242$ ($R^2 = 0.69$)

G. sepium $Y_G = 0.0810Ln(x) + 11.657$ ($R^2 = 0.12$)

C. seed cake $Y_T = 1.1502Ln(x) + 11.649$ ($R^2 = 0.75$)

Control $Y_O = 0.1733Ln(x) + 11.157$ ($R^2 = 0.21$)

The coefficient of determination associated with each equation varied from 0.12 for the *G. sepium* group to 0.79 for the *C. calorthyrsus* group. The regression coefficient indicated the proportion of the variation of the weight that can be explained by the regression curve. The supplements had a relatively high influence on the growth of the WADG during this period of the year.

TABLE I. AVERAGE QUANTITIES OF SUPPLEMENTS AND NITROGEN CONSUMED DURING THE RAINY SEASON (g/ANIMAL/DAY)

Supplements		Weighing Period							
		21 days		42 days		63 days		84 days	
		Intake (g)	N (% of intake)	Intake (g)	N (% of intake)	Intake (g)	N (% of intake)	Intake (g)	N (% of intake)
Calliandra Calothyrsus	FF	304.7		298.1		291.9		293.3	
	DM	131.5		128.6		125.9		126.6	
	N	4.8	80.1	4.7	78.5	4.6	76.8	4.6	77.1
Leucaena Leucocephala	FF	180		287.1		373.3		381.4	
	DM	59.7		95.3		123.8		126.5	
	N	2.8	46.1	4.4	73.6	5.7	95.6	5.8	97.8
Cotton Seed Cake	FF	88.9		88.1		88.8		88.8	
	DM	78.0		77.4		78.0		78.0	
	N	6	100	5.9	99.1	6	100	6	100
Gliricidia Sepium	FF	6.3		11.5		22.7		15.8	
	DM	1.8		3.3		7.7		4.6	
	N	0.1	1.2	0.1	2.2	0.3	5.2	0.2	3

FF = Fresh forage; DM = Dry Matter; N = Nitrogen.

TABLE II. ADJUSTED MEAN WEIGHT (± SE) OF WADG AT DIFFERENT PERIODS DURING THE RAINY SEASON

Treatments	Adjusted mean weight (kg)			
	21 days	42 days	63 days	84 days
Calliandra calothyrsus	11.8 ± 0.84 a	11.9 ± 0.72 b	12.6 ± 0.70 b	12.5 ± 0.68 b
Cotton seed cake	11.7 ± 0.95 a	12.1 ± 0.92 b	13.4 ± 1.02 b	13.0 ± 0.97 b
Gliricidia sepium	11.7± 0.85 a	11.5 ± 0.95 ab	11.9 ± 1.02 ab	11.7 ± 1.00 ab
Leucaena leucocephala	12.3 ± 1.40 a	12.6 ± 1.21 b	12.5 ± 1.05 b	13.1 ± 0.92 b
Control	10.2 ± 0.48 a	10.1 ± 0.56 a	10.0 ± 0.51 a	10.8 ± 0.56 a

a,b: values in the same column with different following letters are significantly different (P <0.05).

The average daily weight gains are presented in Table III. The adjusted average daily weight gain varied from 3.1 g for the control to 20.6 g for the animals supplemented with *L. leucocephala*. In general there was a large fluctuation in the average daily weight gain during the trial.

3.2. Experiment II

3.2.1. Growth and average daily weight gain

Feed supplements distributed to the animals before their release on to the pasture during the dry season were totally consumed. Analysis of variance carried out on weighted data indicated a highly significant difference ($P < 0.01$) in body weight between the control and the treatment groups. However, there were no significant differences between the supplemented groups. A highly significant ($P < 0.01$) interaction was observed between the weight of animals and the weighing periods. On average the gain during the dry season were 0.17 kg for the control group, 1.6 kg for the group supplemented with *L. leucocephala* and 2.0 kg for the group supplemented with cotton seed cake. Given the high cost of the cotton seed cake it is evident that the small-scale farmer cannot use it as a regular feed supplement. Therefore, *L. leucocephala* represents the best alternative. In addition to its use as an animal feed, it can serve as a wind break, as fire wood and to reduce soil erosion and contribute to sustain crop production, particularly in this region where almost all land is under cultivation.
The logarithmic adjustment of the weight with time in weeks gave interesting results (Fig. 1). The coefficient of determination associated with these equations varied from 0.06 for the control group to 0.68 for the *L. leucocephala* group. This indicates that a high proportion of variation in weight can be explained by the regression curve and is related to supplementation.
Table IV indicates the average daily gain for each treatment at different weighing periods. It appears from this table that during period four of the experiment, (i.e. 42–56 days) all animals lost weight. At this time all animals had an attack of coccidiosis. Animals supplemented with cotton seed cake showed an average daily weight gain of 19.9 g, the *L. leucocephala* supplemented group 16.1 g and the control group only 1.7 g.

3.2.2. Progesterone profile

Blood serum progesterone profile varied between 0–0.56 ng/ml for the control group, 0–0.72 ng/mL for the group supplemented with *L. leucocephala*, and 0–1.0 ng/mL for the group supplemented with cotton seed cake. The animals used in this trial had already reached puberty (5–7 months) and physiological maturity (11–12 months). However, no sign of cyclicity was observed.

TABLE III. ADJUSTED DAILY MEAN WEIGHT GAINS OF WADG DURING THE DIFFERENT STUDY PERIODS IN THE RAINY SEASON

Treatments	Adjusted daily mean weight gains (g) Period (days)				Whole experimental period (days) 0–84
	0–21	22–42	43–63	64–84	
Calliandra calothyrsus	20.4	7.1	33.2	–5.7	13.8
Cotton seed cake	15.7	21.3	62.1	–22.9	19.1
Gliricidia sepium	16.6	–7.6	15.9	–7.0	4.5
Leucaena leucocephala	44.0	17.1	–5.9	28.0	20.6
Control	–4.1	–6.7	–2.8	37.1	3.1

TABLE IV. AVERAGE DAILY WEIGHT GAIN OF WADG DURING THE DIFFERENT PERIODS IN THE DRY SEASON

Treatments	Average daily weight gain (g) Period (days)							
	0–14	14–28	28–42	42–56	56–70	70–84	84–98	0–98
Control	–14.2	5	17.8	–22.8	7.1	5	14.2	1.7
L. leucocephala	3.5	12.8	30	–15.7	9.2	31.4	41.4	16.1
Cotton seed cake	25	–15	7.8	–20	53.5	37.8	50	19.9

4. DISCUSSION

4.1. Experiment I

From amongst the three fodder species, *G. sepium* was the least preferred during the rainy season. This low acceptability of *Gliricidia* was probably due to the taste and smell of the plant. This result is similar to that of Bennison and Paterson [8] who compared 8 indigenous browse species including *G. sepium* and *L. leucocephala* and found that *G. sepium* was the least preferred species by goats. Amongst different *G. sepium* ecotypes they also observed significant ($P < 0.05$) differences in preference, Mexican ecotype being less preferred than that of Costa Rica. Jabbar et al. [9] also observed that in West Africa, *Gliricidia* was rarely used as a feed for ruminants because some farmers considered it as poisonous to sheep and goats.

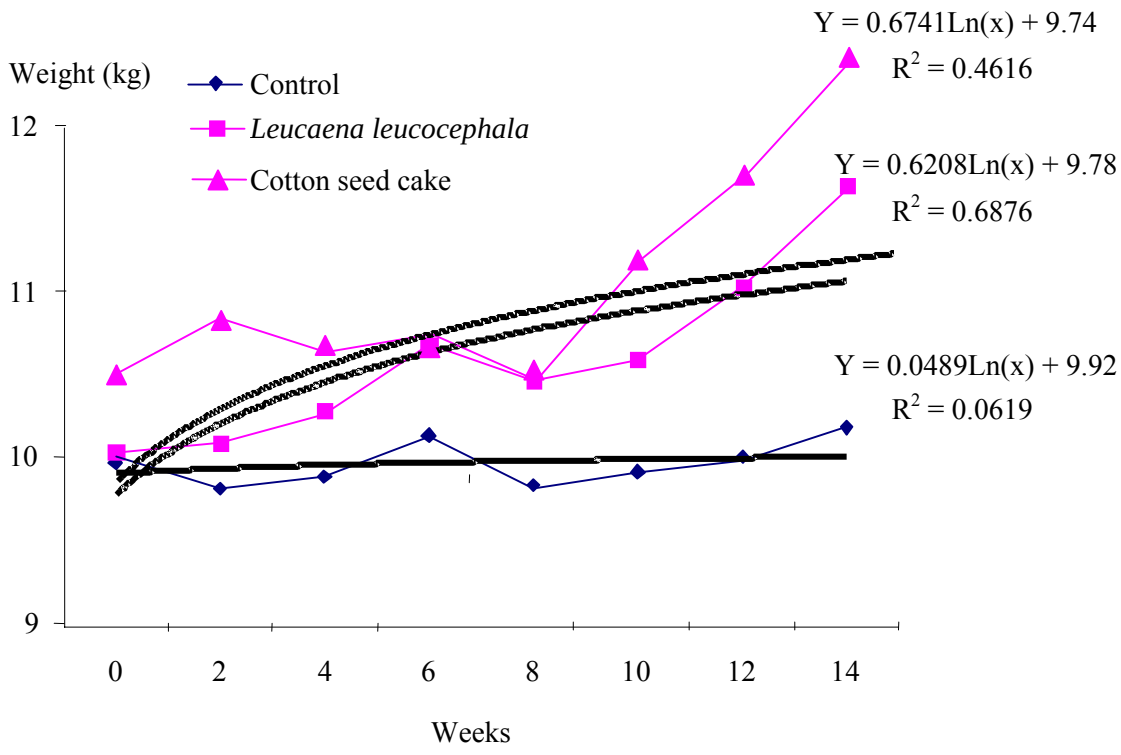

FIG. 1. Response of WADG to supplements of cotton seed cake and Leucaena lecucocephala

L. leucocephala intake was similar to that of *C. calothyrsus*. On the other hand, Paterson et al. [10] observed that *L. leucocephala* was more palatable and more acceptable than *C. calothyrsus, G. sepium* and *S. sesban* species by small ruminants. In the study by Paterson et al. [10], they concluded however that *C. calothyrsus* was the most promising plant species to replace or complement the cultivars of *L. leucocephala* that are presently in use.

During the whole experimental period, the mean live-weights and mean daily weight gains were not necessarily correlated with the supplement intake. This was probably related to the poor rangeland conditions. Most pastures were generally in very poor condition. It was thus very difficult for these animals to achieve adequate growth even when the acceptability of the supplement was good. This confirms the conclusions that the rate of growth and milk production by ruminants grazing tropical pastures or consuming crop residues alone is generally low [3].

G. sepium consumption was so low that the diet of animals supplemented with this forage was similar to that of the control group. This was exemplified by the mean live-weights and the mean body weight gains. The mean weight gain of animals of the control group was 3.1 g, which was higher compared to that observed by Paterson et al. [9] who reported a weight loss of 20 g/day for goats kept on hay alone in Zimbabwe and by Palmer and Tatang [11] who reported a weight loss of 35 g/day on sheep fed on hay alone *ad libitum*.

The average weight gain of animals supplemented with *L. leucocephala* was relatively higher than that of animals supplemented with *C. calothyrsus* or cotton seed cake. Animals from all groups showed a high fluctuation in mean daily weight gain during the whole experimental period. Most of this fluctuation can be related to a typical management problem in the region. Due to animal theft during the feeding trials some farmers decided to keep their animals indoors, and the only feed they received was the supplement or a small amount of forage collected while returning from the farms. Sometimes the quantities of supplements offered were higher compared to the quantity of the basic forage brought by the farmer.

The weight gain of animals supplemented with *C. calothyrsus* was 13.8 g/day. This is lower than the 24 g/day obtained by Paterson et al. [10] in Zimbabwe while supplementing local goats with a diet of 140 g/day of *C. calothyrsus* dry matter. In this situation however the energy source was adequate.

Despite the fact that these animals were raised on-farm in a tropical humid environment, where they are continually exposed to parasitic infestation which weakened the animals and caused growth reduction [12], the growth rate of these animals supplemented with limited amount of leguminous forage at one of the critical period of the year was relatively better.

4.2. Experiment II

This trial was carried out in the dry season. During this period, the nutritive value of forage was quite low. The difference in average daily weight gain observed between the treatment groups and the control can be related to the effect of the supplement. The average daily weight gain obtained in our experiment was low when compared to that of Zemmelink et al. [13] and Thys [14]. Zemmelink et al. [13] recorded a weight gain of 87 ± 21.8 g/day when goats were supplemented with cotton seed cake while Thys [14] obtained 122 ± 14.5 g/day when cotton seed cake and their shells were included in the diet of sheep. These results are however higher than those obtained by Manjeli et al. [15]; 12.65 g/day when they fed WADG on-station with *Pennisetum purpureum* and supplemented with 100 g of cotton seed cake per animal per day. The large difference in average daily weight gain observed between our experiment and those of Zemmelink et al. [13] and Thys [14] may be due to the fact that in their trial cotton seed cake was given *ad libitum*.

Jones [16] in a feeding trial with *L. leucocephala* recorded an increase in weight gain of 14%. Leng [17] observed that feeding goats with *P. purpureum* as a basal diet and supplementing with dry *L. leucocephala* mixed with ground soya gave an average daily weight gain of 45 g while *L. leucocephala* alone gave only 22 g/animal/day. These are in good agreement with the present results.

The progesterone profiles, which were low (ranged between 0–1.0 ng/mL) as compared to the values reported by Vaissaire [18] indicate that these animals were not cycling. Vaissaire [18] observed that in a cycling goat, serum progesterone levels varied between 5 to 16 ng/mL from the 7^{th} to 14^{th} day, then decreased to 0.8 ng/mL during anoestrus.

Theriez [19] observed that animals feed to ensure their maintenance first, then for milk production when there is a young one and only thereafter for reproduction. The same author showed that the ovulation rate increased significantly with the increase of body weight provided that feeding at breeding time is above that required for maintenance. Our experimental animals were bought from the market. We had no information on the manner they had been raised or on their nutritional condition during growth. It was therefore difficult to explain the cause of this anoestrus. Feeding during the first 12 months can affect reproductive performance in small ruminants [19]. Feeding, particularly between 0 and 2 months is critical for optimum reproductive performance at maturity [19]. Improved nutrition, during the production period, while ensuring some form of compensation cannot correct the negative effect of poor nutrition during the early growth. As a result a poorly fed females may not be able to express their genetic potential during the reproductive phase.

If the results of these preliminary investigations, particularly those related to reproduction are confirmed, they will indicate that the negative effect of poor nutrition is generally under estimated. Since in addition to weight loss during the critical period of the year, its effect is serious and insidious during reproduction at maturity. Therefore, the high prolificity which has often been attributed to this species of goats probably manifests itself to a lesser extent as compared to the real potential. It is therefore essential to expand and intensify such investigations on these animals as well as on all other ruminant species in the region.

5. CONCLUSIONS

It was evident from these feeding trials that *L. leucocephala* was the most consumed shrub legume yielding the highest live weight. Despite the high daily weight gain of animals fed on cotton seed cake, this by-product is relatively expensive (0.5 US$/kg) and given the economic status of local farmers, it is difficult for them to provide this feed as a supplement in a sustained manner to their animals. Thus, *L. leucocephala* and *C. calothyrsus* appear to be the most appropriate leguminous browse species for a sustained small ruminant production in this highly populated area of Cameroon.

The supplementation improves growth and body conformation of the animals. These animals are sold not only on the basis of their weight but also of their body conformation. With an increase of about 3 kg/animal in three months and a good body conformation, a farmer will be able to earn additional revenue of at least 4500 CFA without incurring any additional costs, besides labour costs. This represents a substantial gain for the farmers with almost no investment. In addition to body weight gain the use of leguminous browse improves soil fertility and structure, provides firewood to the household and acts as a windbreak when planted in a farm. The level of plasma progesterone was very low in all the experimental animals. Thus, at the levels studied supplementation had no effect on this parameter.

REFERENCES

[1] PAMO TEDONKENG, E., PIEPER, R.D., Effect of fertilization and cutting frequency on the yield of *Brachiaria ruziziensis* in Adamaoua Plateau Cameroon, Tropicultura, **13**, 1 (1995) 9–14.

[2] CROWDER, L.V., CHLEDA, H.R., Tropical Grassland Husbandry, London and New York: Longman (1982).

[3] FAO Animal Production and Health Paper, Tree foliage in ruminant nutrition, FAO, Rome (1997).

[4] RIVIERE, R., Alimentation des ruminants domestiques en milieu tropical, La Documentation Française (1991).

[5] DEVENDRA, C., BURNS, M., Goat production in the tropics, Commonwealth Agricultural Bureaux (1983).

[6] STEEL, R.G., TORRIE, J.H., Principles and procedures of statistics, 2nd edn McGraw Hill Publishing Company, New York (1980).

[7] FAO/IAEA, Progesterone RIA kit. Animal Production and Health Section, Seibersdorf, Austria (1996).

[8] BENNISON, J.J., PATERSON, R.T., Use of trees by livestock. 3. *Gliricidia*. Chattan, UK, Natural Resources Institute (1993).

[9] JABBAR, M.A., REYNOLDS, L., LARBI, A., SMITH, J., Nutritional and Economic Benefits of *Leucaena* and *Gliricidia* as feed supplements for small ruminants in Humid West Africa, Trop Anim. Hlth. Prod. **29** (1997) 35–47.

[10] PATERSON, R.T., ROOTHAERT, R.L., NYAATA, O.Z., AKYEAMPONG, E., HOVE, L., "Experience with *Calliandra calothyrsus* as feed for livestock in Africa", Forest, Farm, and Community Tree Research Reports (Special Issue), (EVANS, D.O., Ed.), Winrock International, Morrilton, Arkansas, USA (1996).

[11] PALMER, B., TATANG, M. I., "*Calliandra calotyrsus* forage for the tropics — a current assessment", Forest, Farm, and Community Tree Research Reports (Special Issue) (Evans, D.O Ed), Winrock International, Morrilton, Arkansas, USA (1996).

[12] KERBOEUF, D., GODU, J., Les strongyloses gastro-intestinales: données générales, Colloque International Niort (France), (1984), 28.

[13] ZEMMELINK, G., TOLKAMP, B.J., MEINDERTS, J.H., "Feed intake and weight gain of West African dwarf goats", Sheep and goats in humid west Africa, (SUMBERG, J.E., CASSADAY, K., Eds.), Proceeding of the workshop of small ruminant production systems in the humid zone of West Africa, Ibadan, ILCA, Addis Ababa, Ethiopia, (1985).

[14] THYS, E., L'utilisation du tourteau et de coques de coton à haute dose dans l'alimentation des brebis de l'extrème Nord Cameroun. Observation préliminaires. Tropicultura, **7** (1989) 132–136.

[15] MANJELI, Y., TCHOUMBOUE, J., TEGUIA, A., ZANGO, P., Productivity of West African Dwarf goats under traditional management in the Western highland of Cameroon. World Review of Animal Production. **31** 1/2 (1996).

[16] JONES, R.M., "The role of Leucaena in improving the productivity of gazing cattle", Forage tree legumes in tropical agriculture, (GUTTERIDGE, R.C., SHELTON, H.M., Eds.), CAB International, U.K. (1994).

[17] LENG, R.A., Trees foliage in ruminants nutrition, FAO Animal Prodcuction and health Paper No. 139, (1997).

[18] VAISSAIRE, J.P., Sexualite et reproduction des mammiferes domestiques et de laboratoire, (MALOINES, S.A., Eds) (1977).

[19] THERIEZ, M., Influence de l'alimentation sur les perfromances de reproduction des ovines, Journees Rech. Ovine et caprine (9 ed), (1984) 294–326.