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Sexual Activity of Local Sahel Goat Breed in Niger

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Authors' contributions

Authors MM, HI and MGM designed the study, oversaw data collection, performed statistical analysis, and wrote the first draft of the manuscript. Author MM managed the documentary research. Authors MH and SGJ approved the protocol and read and amend the first draft of the manuscript. All authors read and approved the manuscript before submission.

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ABSTRACT

Aims: In Niger, the Sahel goat breed counts for around 80% of the national goat herd. However, it is scientifically little or not known. Thus, one of the aims of its zootechnical characterization is the control of its sexual activity, a fundamental physiological basis of reproductive function.
Study Design: For this purpose, a sample of 47 Sahel goats in two phenotypically different sub-samples: from the Tahoua region (22) and Tillabéry region (25) was installed and monitored for heat control in order to characterize female sexual activities.
Place and Duration of Study: The study was conducted for a period of 9 months (January to September) at the experimental station of University of Niamey Faculty of Agronomy.
Methodology: Heat controls by using harnessed males with a non-marking protective apron were carried out twice daily (8 am and 5 pm).
Results: A total of 146 heats and 100 cycles were observed. It appeared that heat starts and ends mostly in the morning (76% and 70% respectively). Annual sexual activity has gone through two phases. A phase of an almost total rupture of heat from February to April and a phase of regular sexual activity from May to September and by extension the rest of the year. The mean duration of estrus and sexual cycle are respectively 35.75 ± 15.72 hours and 20.9 ± 9.7 days with strong individual variations (12 to 132 hours and 4 to 55 days for respective estrus and sexual cycle). The

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"T" test showed that there are no significant differences in these parameters between the two sub-samples (Tahoua and Tillabéry).
Conclusion: Ultimately, the estrus and sexual cycle of Niger Sahel goat are common to those of the goat species in general.

Keywords: Cycle length; estrus duration; annual sexual activity evolution; sahel goat; Niger.

1. INTRODUCTION

Numerically most important among animal species, hardy, and well adapted to harsh conditions, goats are particularly useful for improving animal production in tropical countries [1,2]. One of the necessary conditions of this aim is the control of reproduction. Several authors [3,4,5,6,7] are unanimous on the fundamental role of reproductive function for all types of animal production (herd productivity, milk, meat, skin ...). According to Bodin et al. [3], reproductive outcomes strongly influence the economic viability of farming and its improvement is part of the common requirements in substantially all types of production. However, the physiological basis of the reproductive function is the sexual function whose knowledge is the first condition for rational intervention to control the sexual cycle in all its components, to improved reproductive parameters. As fundamental determinants of the efficiency of reproduction in goats, Greyling [8] noted the length of the reproductive season, cyclic activity, ovulation and fertility rate. Indeed, it has been shown that late estrus associated with late ovulation and LH peak may be responsible for low fertility [9]. Then sexual cyclicality control is the foundation of the reproduction control, thus improving domestic ruminant's productivity.

In Niger, the domestic herd numbered 36% goats, of which 80% were Sahel goat breed's [10]. This goat breed was omnipresent in all agro-ecological zones of Niger. Investigations on its phenotypic characteristics [10] and [11] had revealed three phenotypic ecotypes whose dominant traits were: large size with long and drooping ears, long horns, phaeomelanic pigment pattern and red magpie coat in Tillabéri region; medium-sized goats, stalked ears, chocolate eumelanic pigment pattern and red magpie coat in Niamey and large animals, short and stalked ears, short horns, black eumelanic pigment pattern and black magpie coat in Tahoua region.

Apart from the phenotypical characterization, one of the first objectives retained in the framework of zootechnical characterization of Sahel goat breed in Niger is the characterization of its cyclicality through the assessment of heat temporary manifestation and the establishment of temporal parameters of the cyclicity including periods of estrus and sexual cycle.

2. MATERIALS AND METHODS

Investigations were conducted over nine (9) months from January to September 2013 at the experimental station of the University of Niamey Faculty of Agronomy, at coordinates 18 ° 30' north latitude and 08 ° 2' east longitude. It concerned forty-seven (47) Sahel goats, from Tillabéry (Tera department) and Tahoua (Abalak department) regions in the range of 25 and 22 goats respectively. In previous studies [10,11] Sahel goats were found phenotypically different between the two regions. Table 1 shows the characteristics of these goats (Number by age group and origin as well as mean weight according to origin) at the beginning of the experimentation. All animals are identified with ear loops. They are split into two (2) parks (Tahoua and Tillabéry) because of their number. Each park has a tap and collective feeder and trough. These parks are divided into two parts each: first one under a large shed that served as a food and rests place and the second which is open-air served as an exercise place and where heat controls were conducted. Animals were kept free-stall. They were fed on *Zornia glochydiata* from January to April 2013, and then, on bourgou (*Echinochloa stagnina*) since mid-April 2013. These forages are well known because of their palatability and high nutritional value. The animals were given a daily supplementation of wheat bran and watering with potable water and supplementation based industrial salt Lick were *ad libitum*.

Regarding health care, all the animals were dewormed with ivermectin at the beginning of the study and the start of the rainy season. They were also vaccinated against small ruminant's plague. Periodic health monitoring is provided by a private veterinarian. A stock of zoo-veterinary products was introduced for occasional clinical cases.

Table 1. Distribution of goats according to ages and origin and mean weights by origin at the beginning of experiments

Number of pairs of permanent incisors	Corresponding ages (years)	Origins	
		Téra	Abalak
1	1 - 2	4	4
2	2 - 3	9	6
3	3 - 4	10	10
4	> 4	2	2
Total		25	22
Mean weight of goats		21.7±2.13	21.43±3.55

Heat controls were carried out twice daily (8 am and 5 pm) by exposure for one (1) hour of females to bucks harnessed protective aprons without a marker. These bucks have been purposely trained since the beginning of the experiments. Four (4) to six (6) bucks were used in rotation between female's parks at each control. This was done for accuracy because it is well known that a heated female can accept one buck and refuse another. Receptivity, stillness, and acceptance of overlapping of female to buck are considered the telltale signs of early heat.

The monthly weighing was carried out for all the goats at the beginning of each month. Weight at the beginning of the month "M" is considered the average weight of the animal during the preceding month "M-1".

Figs. 1 and 2 show the monthly evolution of the mean temperatures and precipitations from 1999 to 2013 in Niamey and Fig. 3 shows the evolution of monthly weights of the goats during the observation period (January-September 2013). Data (dates and times for the beginning and end of estrus) were listed on a card collection devised for this purpose.

There are various methods of detection of estrus. The method applied in this study was similar to that used by Derquaoui et al. [12] on the goat D'man in Morocco, Tamboura et al. [2] on the Mossi local goat breed in Burkina Faso.

To calculate the parameters of the cyclicity (estrus and sexual cycle durations), the following definitions given by Yénikoye [13] were used:

- the onset of estrus is considered as half of the time interval between the first observation of heat and one before;
- the end of estrus is defined as half of the time interval between the last observation of heat and the first observation in which the overlap is not accepted;
- the duration of the sexual cycle is evaluated by the time between two consecutive starts of a heat event.

Typology of sexual cycle reported by Baril et al. [14] as short (less than 17 days), normal (17-25 days), and long cycle (more than 25 days), was taken into account.

Data were analyzed by SPSS 17.0 software. Statistical comparison analysis (Analysis of variance, "T" tests, chi-square test) and correlation test were performed to assess the impact of origin, age, time of year, and the overweight state of goats on the cyclicity parameters.

3. RESULTS AND DISCUSSION

3.1 Heat Manifestation

About 76.6% of experimental goats, 80% of those of Tera, and 72.72% of those of Abalak showed signs of heat. One hundred and forty-six (146) heats and one hundred (100) cycles for all age groups were counted (Table 2).

The evolution of the frequency of heat manifested by month (Fig. 4) shows a breakdown of heat from February to April. After a recovery in May, the number of heats observed increased up to an optimal level in August and fall in September. Considering the months during which more than five (5) heat was observed especially January, May, June, July, August, and September, the chi-square test indicates that there are no differences statistically significant of this evolution according to goat's origin.

Daily distribution of heat manifestations (Fig. 5) shows that they start and end mainly in the morning.

Table 2. Number of heats and cycles observed according to origin and age groups

Origins of goat	Ages (years)	Number of goat	Number of heat	Number of cycles
Téra	1 – 2	3	12	9
	2 – 3	8	24	14
	3 – 4	7	33	23
	> 4	2	17	13
Total Téra		20	86	59
Abalak	1 – 2	2	5	3
	2 – 3	4	9	4
	3 – 4	8	36	27
	> 4	2	10	7
Total Abalak		16	60	41
All origins	1 – 2	5	17	12
	2 – 3	12	33	18
	3 – 4	15	69	50
	> 4	4	27	20
Total		36	146	100

3.2 Temporal Characteristics of Cyclicity

Table 3 presents the mean and extreme duration of temporal cyclicity parameters by the goat and depending on origin. It appears that the average duration of estrus for 146 observations is 35.75 ± 15.72 hours. However, Table 3 shows individual and between the individual's variations of heat duration. Between individuals, heat range from 12 to 132 hours, and individually, durations of heat most frequently observed were 24 hours (41.8%), 36 hours (30.8%) and 60 hours (15.8%). Heat durations of 12 and 72 hours were observed respectively 3 and 5 times and maximum heat duration of 84 and 132 hours were observed once each. "T" test ($p = 0.05$) revealed no differences statistically significant of heat duration depending on origin ($p = 0.237$). Regarding to sexual cycle, the mean duration for 100 cycles observed was 20.9 ± 9.7 days.

Like estrus duration, the sexual cycle also shows individual and between individual's variations from 4 to 54.5 days. These variations allow establishing the following typology: short cycles of 4 to 10 days (21%), normal 19 to 24.5 days (61%) with a high prevalence of 21 days cycle (17% of total cycle observed) and long cycles from 26 to 54.5 days (18%). "T" test showed that there were no significant differences between sexual cycle duration in time of origin ($p = 0.234$).

Table 4 presents the mean and extreme duration of estrus and sexual cycle according to goat's ages at the start of experiment. This table shows that there are no statistically significant differences of these parameters according to age (ANOVA, $p = 0.05$).

In addition, it emerged from ANOVA that month has a significant influence on the duration of sexual cycle ($p = 0.001$) and not on the duration of estrus ($p = 0.234$). The Scheffe post hoc test showed that significant differences were observed between January (6.4 ± 1.9 days) and May, June, July and September respectively on average 27 ± 13.3; 23.8 ± 6.9; 23.4 ± 8.4 and 21 ± 9.6 days of sexual cycle duration's.

To assess the influence of the overweight state of goats or in other words goat's feeding factors on the parameters of cyclicity, Table 5 shows the results of test of correlation between the duration of estrus and sexual cycle and goat's monthly mean weight. It appears that there are low correlations ($0 < r < 0.2$), not significant ($p = 0.73$ and $p = 0.9$) between the durations of the estrus and sexual cycle and weight of goats.

3.3 Discussion

The mean weight of the goat's herd varied in the observation period (Fig. 3), certainly due to environmental conditions of temperature and precipitation. Indeed, weight has increased slightly from January to April. The decline observed in April can be the result of combined actions of high temperature (Fig. 1) from this month (with an optimum in April), with rainfall (Fig. 2) from May.

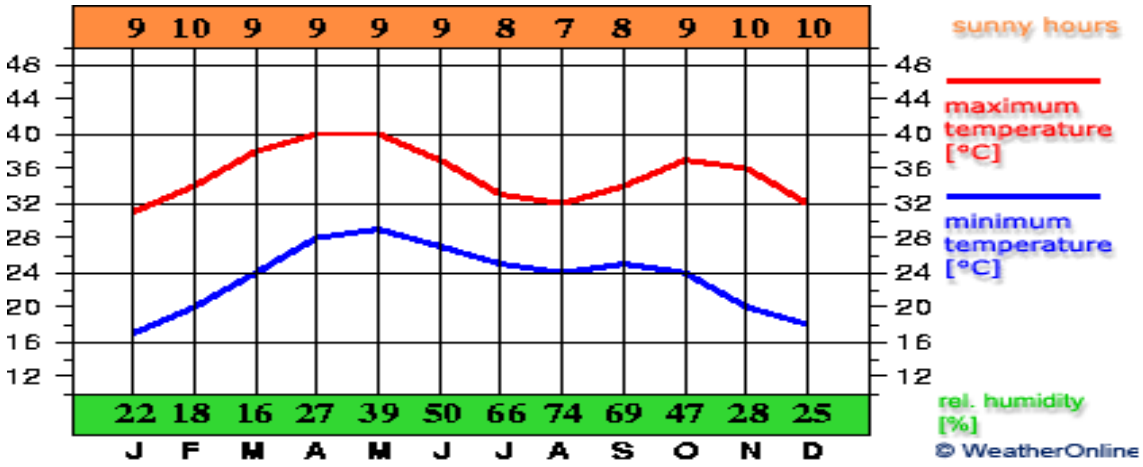

Fig. 1. Evolution of monthly mean temperature from 1999 to 2013 in Niamey (Weather on line, 2013)

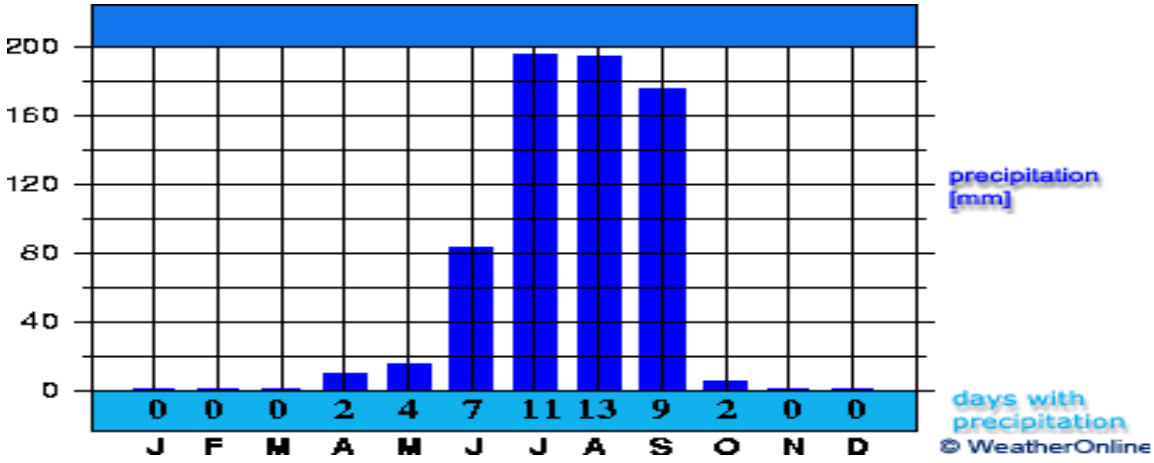

Fig. 2. Evolution of the monthly mean rainfall in Niamey from 1999 to 2013 (Weather on line, 2013)

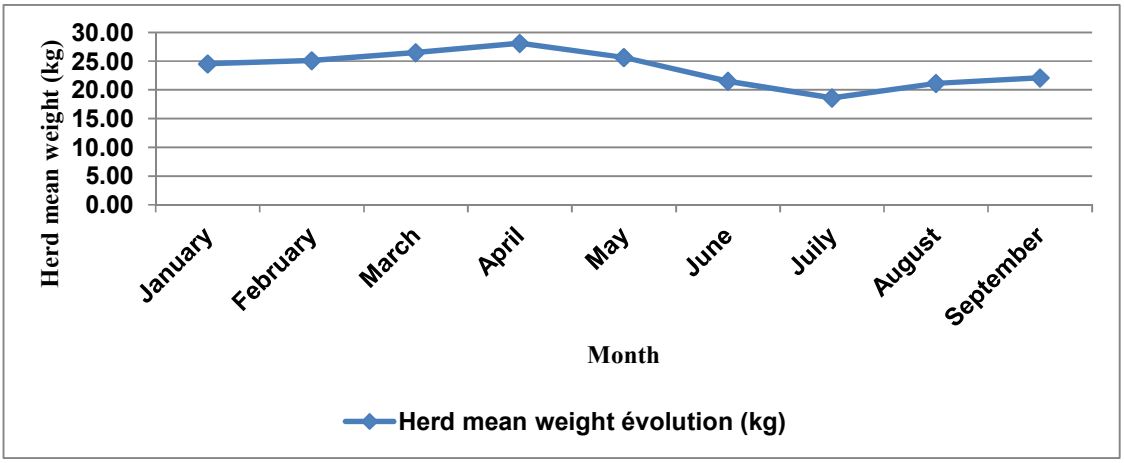

Fig. 3. Evolution of monthly mean weight of goat's herd (January to September)

Table 3. Individual mean and extremal duration of heat and sexual cycle

Origins	Number of goat	œstrus durations (hours)				sexuel cycle durations (days)			
		N*	Mean	Min**	Max**	N*	Mean	Min	Max
Téra	5000	2	36±16.97	24	48	1	21.000	21.0	21.0
	5002	2	60.000	60	60	1	21.000	21.0	21.0
	5003	1	72.000	0	72	-	-	-	-
	5004	5	38.4±10.04	24	48	4	13.88±8.84	6.0	22.5
	5005	1	24.000	0	24	-	-	-	-
	5006	4	30±6.93	24	36	3	17.33±10.28	5.5	24.0
	5008	2	24±16.97	12	36	1	10.000	10.0	10.0
	5009	3	24.000	24	24	2	21.5±1.41	20.5	22.5
	5011	2	36.000	36	36	1	23.500	23.5	23.5
	5012	2	24.000	24	24	1	32.000	32.0	32.0
	5013	3	32±6.93	24	36	2	22.75±35	22.5	23.0
	5014	5	33.6±13.15	12	48	4	15±9.86	6.0	24.5
	5015	8	28.5±8.93	24	48	6	20.83±0.41	20.0	21.0
	5016	8	30±9.07	24	48	6	21.17±8.04	5.0	26.0
	5018	7	48±9.8	36	60	5	23.8±5.82	19.5	34.0
	5019	1	24.000	24	24	-	-	-	-
	5020	2	54±25.46	36	72	1	20.600	20.6	20.6
	5022	5	26.4±5.37	24	36	4	27.25±9.88	21.0	42.0
	5024	9	42.67±20	24	72	7	17.07±11.89	5.0	38.0
	5025	8	30±6.41	24	36	6	21.25±17.92	5.5	54.5
	Total Téra	86	34.47±13.63(a)	12	72	59	19.93±9.31(a)	5	54.5
Abalak	5026	6	28±6.2	24	36	4	16.25±6.18	7.0	20.0
	5027	8	39±12.42	24	60	7	21±12.75	4.0	37.0
	5028	4	33±18	12	48	3	17.17±9.83	6.0	24.5
	5030	1	36.000	36	36	-	-	-	-
	5031	7	46.3±38.84	24	132	5	23.1±12.65	9.5	44.0
	5033	3	52±6.93	48	60	2	28.75±12.37	20.0	37.5
	5034	3	28±6.93	24	36	2	17±14.14	7.0	27.0
	5037	2	36±16.97	24	48	1	37.000	37.0	37.0
	5038	9	34.67±11.14	24	48	7	18.5±8.79	6.0	27.0
	5049	3	36±12	24	48	2	20±1.41	19.0	21.0
	5041	4	60±21.91	36	84	3	17±8.66	7.0	22.0
	5042	1	24.000	24	24	-	-	-	-
	5043	5	28.8±6.57	24	36	3	33.67±10.75	23.0	44.5
	5046	1	24.000	24	24	-	-	-	-
	5047	5	33.6±10.04	24	48	4	22.75±2.02	20.0	24.5
	5049	4	30±6.93	24	36	2	29.5±0.71	29.0	30.0
	Total Abalak	60	37.6±18.28(a)	12	132	41	22.29±10.2(a)	4	44.5
general Total		146	35.75±15.72	12	132	100	20.9±9,7	4.0	54.5

** N = numbers of heats and sexual cycles; (a) Mean durations of heats and sexual cycles are not statistically different depending on origin; ** Min = Minimum and Max = Maximum*

From Data obtained, thirty-six (36) goats who expressed heats, one hundred and forty-six (146) heats, and one hundred (100) sexual cycles observed are fairly representative to conclude temporal sexual behavior of Niger Sahel goat.

Evolution between months of heat manifestation showed two (2) phases. The first one is characterized by a slowdown of sexual activity (or anestrous) from February to April, heats were hardly observed, and a second phase of maximum activity from May to September. Similar behavior of the estrous and ovarian activity was observed by Derquaoui et al. [14] on the D'man goat of Morocco.

Given that tropical region, goats do not show marked seasonality and can reproduce throughout the year [1],15], this sexual behavior of Sahel goat can be attributed to environmental

conditions. According to Devendra and Burns [16], in some regions, limited periods of estrus or ovulatory activities can be associated with specific environmental conditions such as the arrival of rain, temperature variations, or lush pasture. In this case, rapprochement of Fig. 1, 2 and 4 showed that the observed slowdown phase overlaped with the period of high temperature in Niamey, the recovery in May is synchronous to the beginning of the rainy season, the phase of intense sexual activity observed matches with the period of high precipitation and humid weather when the thermal amplitudes are low in Niamey. However, the hypothesis of the action of photoperiod as reported in the literature is not to be ignored, because according to the solar radiation duration in Niamey (Fig. 1), the maximum heat is observed in July and August, a time during which this radiation is shorter, 8 and 7 hours respectively. Indeed, according to Baril et al. [14] and Gayrard [17], the secretion of melatonin mediator used by photoperiodic races to "translate" the effects of light on reproduction is important when nights are long after a period of short nights. Given that goat can ovulate without showing estrus behavior [12,1], continuing heat monitoring associated with hormonal such as progesterone analysis [18] or ovaries activity direct observations by ultrasound or endoscopy will clarify this slowdown behavior of sexual activity observed in Sahel goats of Niger.

Table 4. Mean and extreme durations of estrus and sexual cycle depending on goat's ages at the beginning of experiment

Ages (years)	Estrus duration (hours)				sexuel cycle Duration (days)			
	N*	Means	Min	Max	N*	Means	Min	Max
[1; 2]	17	40.94±14.1$^{(a)}$	12	72	12	19.22±11.1$^{(a)}$	6	37
[2; 3]	33	34.55±13$^{(a)}$	24	72	18	23.08±7.4$^{(a)}$	5	34
[3; 4]	69	34.96±17.8$^{(a)}$	12	132	50	21.35±8.9$^{(a)}$	4	44
> 4	27	36±14.12$^{(a)}$	24	72	20,	18.83±12.5$^{(a)}$	5	54.5
Total	146	35.75±15.72	12	132	100	20.90±9.7	4	54.5

** N = numbers of heats and sexual cycles*

Means in the same column with the same exposed letters are not significantly different (ANOVA, P = 0.05)

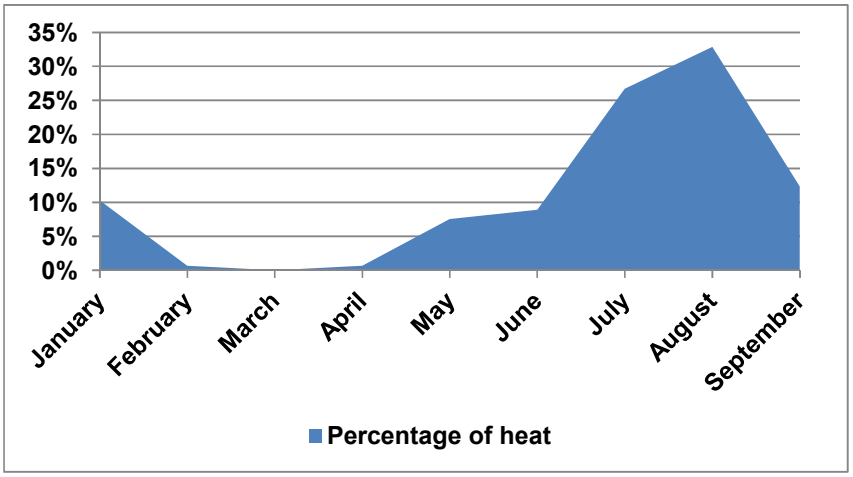

Fig. 4. Evolution of frequency of heat manifestation by month

Table 5. Relationship between the cyclical characteristics and overweight state of goats

Variables	N*	r	P	significance
Heat duration's Mean weight of goats	128	0.03	0.73	ns
Sexual cycle duration's Mean weight of goats	89	0.013	0.9	ns

** N = number of observations r = Pearson correlation coefficient, p = probability of significance (significant correlation if p < 0.05 and not-significant if p > 0.05), ns = not significant*

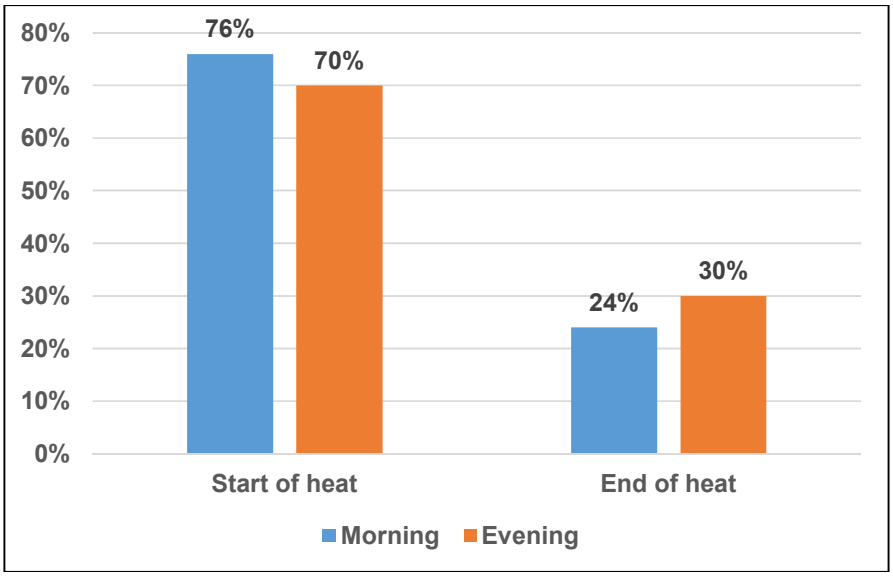

Fig. 5. Distribution of the diurnal expression of heat

Heat diel distribution shows that it has begun and ends mainly in the morning. These results are consistent with those of Mani [19] on the Maradi red goat in Niger. However, Zarrouk et al. [15] reported that estrus occurred especially in the morning (35%) and 25% in the afternoon.

The mean duration of estrus is 35.75 ± 15.72 hours ranging from 12 to 132 hours, but 88.4% ranging from 24 to 60 hours with a high proportion of 24 hours estrus (41.8 %). This mean duration was similar to that of the Boer goat, 37.4 ± 8.6 hours [8], but less than that of the red goat of Maradi obtained under the same environmental experience conditions [19] which was 41 ± 16.4 hours and much higher than 20 ± 2 hours of Mossi goat of Burkina Faso [2].

However, individual and between individual's variations of estrus duration observed exceed 24 to 56 hours obtained by Greyling [8] and were similar to those obtained by Mani [19] and Tamboura et al. [2], which were respectively 24 to 72 hours and less than 6 hours to more than 96 hours. These differences were in concordance of variations between breeds reported by Zarrouk et al. |15].

Sexual cycle lasts about 21 days in accordance with what was reported in the literature [20,21,22,23,2,24,8,15] and [19].

The typology resulting from individual and between individual's variations highlights three types (short, normal, and long) with a large proportion (61%) of normal cycles (19 to 24.5 days) and 39% of abnormal cycles short and long. The relative importance of normal cycles was consistent with the results reported by Baril et al. [13], Greyling [8] and Mani [19] respectively on the Alpine, Boer and Maradi red goats. The typology of the sexual cycle is often variously assessed according to criteria. Thus Akusu et al. [25] qualified as means cycles of 16 to 27 days observed mainly in the dwarf goat of West Africa while Derquaoui et al. [12] have divided D'man goat of Morocco cycles into two types: short cycle times (5-16 days) with a mean of 10.5 ± 3.45 days and long cycles (17 to 26 days) with a period average of 20.96 ± 2.24 days. Unlike Zarrouk et al. [15] who stated that short estrous cycles were observed at the beginning of the season of sexual activity probably associated with premature regression of the corpus luteum, those observed by Sahel goat were displayed by some individuals at any moments of the observation period.

Statistical tests showed that there were no statistically significant differences in duration of estrus and sexual cycle by origin, age and weight of goats stating that the data obtained are characteristic of the breed. However, it was found significant differences in the cycle depending on the time of year.

4. CONCLUSION

At the end of this study, it was found that Sahel goat has a dead period or low sexual activity

from February to April for the period of the hot dry season, characterized by high temperatures i.e Niger summer. Estrus and sexual cycle are characterized by strong individual variations typical of goat species. The averages were: 35.75 ± 15.72 hours estrus ranging from 12 to 132 hours with a high proportion (42%) of estrus periods 24 hours and sexual cycle 20.9 ± 9.7 days ranging from 4 to 54.5 days with a large proportion (61%) of normal cycles (19 to 25 days). However, statistical tests showed that the two goat sub-samples: Tahoua (Abalak) and Tillbéri (Téra) were not statistically different for all cyclicity parameters discussed (manifestation of estrus, duration of estrus and sexual cycle). The recovery protocol during the off-season or low sexual activity combined with the endocrinology of the sexual cycle or assessment of ovarian activity by endoscopy or ultrasound is needed to confirm or refute the observed behavior.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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