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Preparation for genetic improvement of breeds through the comparative study of the effects of two heat induction methods (vaginal sponges and PMSG): the case of the Sahel goat in Niger.

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ABSTRACT:
In Niger, goats are in first place with 36% of the livestock. In spite of this position, a decrease in fertility from 123.2% to 83.62% and in fertility from 87.07% to 65.02% was observed in 1998. Therefore, in order to increase the reproductive capacity of goats, we compared the effects of two hormonal methods of heat induction and synchronization in the Sahelian goat during the off-season in the urban commune of Tillabéri. The herd is composed of eight goats of different ages separated into two batches of 4 goats each. Two multiparous goats and two kids make up each batch.v Batch 1 animals received a vaginal sponge treatment followed by an injection of PMSG while batch 2 animals received two injections of PMSG at a dose of 0.5 ml each at 11 day intervals. An aproned billy goat was used for heat detection. At 23 hours after removal of the vaginal sponges, 75% of the goats in batch 1 came into heat, whereas in batch 2 it took 3 days for 50% of the goats to respond favourably. Parity and age influenced heat induction (p= 0.001). Multiparous goats responded quite favourably and quite quickly to hormone treatments for heat induction and synchronization than primiparous goats. Now the question we are going to ask ourselves is whether we will get the same results with a treatment based exclusively on vaginal sponge.

Keywords: Induction, heat, Sahelian goat, synchronisation, vaginal sponge, PMSG

1. INTRODUCTION:

The goat provides several benefits, hence the growing interest in its breeding. Since the domestication of the goat about 10,000 years ago (FAO, 2007), its presence and involvement in the activities of societies has not only been uninterrupted, but has also been of great significance, including religious. West Africa, with 37.2% of the continental goat population, is one of the main breeding areas for this species with a particularly important socio-economic role. The goat is raised in a variety of agro-ecological zones and systems, but it is especially present in the most arid regions where it plays a major role in subsistence and securing agrarian systems (Missohou et al., 2004). In West Africa, goat farming, because of its potential and multifunctionality, can play a major role in the fight against poverty and food insecurity, especially in animal-based foods (Missohou et al., 2016). Goats are one of the most important sources of meat in rural areas where it is not common to slaughter cattle during social and ritual events. Indeed, their small size and low carcass weight correspond to the consumption needs of a rural household for a day and allows to free oneself from the constraints of meat conservation (Missohou et al., 2016). Goat's milk is also hypoallergenic and has a high casein content with high nutritional value (Missohou et al., 2016). Its high vitamin content justifies its use in the fight against malnutrition in children (Missohou et al., 2016). It rarely contains tubercle bacilli, but is rich in small fat globules, making it easy to digest (Missohou et al., 2016). This species is of paramount importance for the many functions it performs: it serves as a bank account that can be converted into cash in case of need, it is used as a gift to strengthen relationships between people. In addition, it provides milk and meat, which are high quality foods (CTA, 2004). Moreover, the advantage of

goat breeding lies in its reproductive performance (sexual precocity, multiple litters, short intervals between generations, gestation period of 5 to 6 months allowing for three goat breedings every two years (Devendra, 1980) and in their capacity to adapt to the extreme conditions of the Sahelian climate. At the macroeconomic level, in Niger, for example, the value of livestock, 31.1% of which is goats, is estimated at CFAF 2000 billion.) Goat skin, which is partly used for local handicrafts, is a significant source of foreign exchange (Rhissa, 2010). Milk production increased from 969,800 litres in 2015 to 1,467,000 litres in 2020. The annual rate of increase in milk production rose from 42% in 2018 to 83.47% in 2019, a gain of 41.47 percentage points. Despite this increase, local demand is not being met. Indeed, Niger imports on average more than 17 billion CFA francs of milk and dairy products each year, i.e. 50% of its needs (PDDS, 2021). Technically, the Maradi red goat skin has exceptional structural qualities such as a pronounced and deep grain, elastic, dense, compact and low-fat fibres. It is also easy to work, giving a supple and nervous skin sought after for luxury leather goods, gloves, glacé, suede and velvet-like clothing and quality footwear (Robinet, 1967). Despite a renewed interest in small ruminants in general (Missohou et al., 2016), knowledge about goats in West Africa is still fragmentary, partial and old (Missohou et al., 2016). Goat farming has long been neglected politically and scientifically in favour of cattle, which were believed to be the only ones capable of producing large tonnages of meat (Missohou *et al*., 2016). Some countries have even advocated its elimination, accusing it of promoting desertification (Amégée, 1986). Also, the world production of goat milk, estimated at 15 million tonnes, remains marginal in the world milk production (only 2%), largely dominated by cow's milk (83%) and buffalo milk (13%). Global goat meat production, at around 5 million tonnes, is also small in the diverse universe of meats, equivalent to only 8% of beef but 60% of sheep meat (Missohou *et al*., 2016). Pre-weaning mortality of kids is very high and constitutes one of the main constraints of goat farming in West Africa. It is due to pneumopathies, in particular peste des petits ruminants, and gastrointestinal parasitosis. Growth performance is also poor with average weights at 12 months of age exceeding 20 kg in only a few genetic types (Missohou *et al*., 2016). Despite this potential, the sector remains poorly developed, giving way to an increasing import of non-African livestock products, particularly from Brazil, participants lamented (Zoungrouna, 2018). Livestock production systems are mainly traditional (pastoral, agropastoral and sedentary), with some peri-urban systems. The productivity of goat farms is low (Missohou *et al*., 2004). In order to respond to a global increase in demand for meat and milk and to adapt to changes in production and marketing methods, livestock farming faces a major challenge: to increase its production volumes while preserving natural resources, the multiple forms of agriculture and the farmers who depend on them (Alexandre *et al*., 2012). The technical or management strategies used today by breeders to control reproduction basically concern hormonal treatments to induce and synchronise oestrus and ovulation, whether or not associated with artificial insemination, hormonal treatments to trigger farrowing, photoperiodic deseasoning treatments and the male effect. Hormonal treatment is used in all seasons to induce oestrus and ovulation, and to cluster farrowing. Estrus and ovulation control methods can allow the timing of AI to be chosen and females to be inseminated only once at a specific time, while maintaining a satisfactory level of fertility (Fatet *et al*., 2008). This is why we asked ourselves the following research question: Is it possible to synchronise heat in the Sahelian goat in Niger? If yes, How ?

1. MATERIAL AND METHOD:

2.1. MATERIAL:

2.1.1. Presentation of the urban commune of Tillabéri:

The urban commune of Tillabéri is located between 1°27"10"' East longitude and 14°12"33" North latitude on the left bank of the Niger River, 113 km west of Niamey, the capital of Niger, on the national road N°1 which leads to the Republic of Mali. It is located in the North-Sahelian zone with a hot and humid climate. Rainfall is irregular and ranges from 150 to 300 mm per year. The town of Tillabéri was declared an urban commune in 1988. The city of Tillabéri was declared an urban municipality in 1988 and since 2005 has been the capital of the region and the department that bears the same name. It consists of an urban centre and a few peripheral and island villages. Its surface area has increased from 450 Km2 to 97251 Km2 in 2016. It has approximately 63505 inhabitants in 2020. Its population is made up of Sonrais, Tuareg, Fulani, Hausa, Germa, Wogo, Gourmanthé and expatriates. The commune is crossed by the Niger River, on which hydro-agricultural facilities (Djédja, Dayibéri, Dayikaina, Toula, Tillakaina) have been built for rice cultivation. Other rice-growing activities are carried out on the Mari pond and on the edge of the sea, which is not developed during the winter season. Ruminant breeding is practised in almost all households in the commune; fishing is also practised on the water points and on the River Niger. The figure below shows the geographical location of the study area.

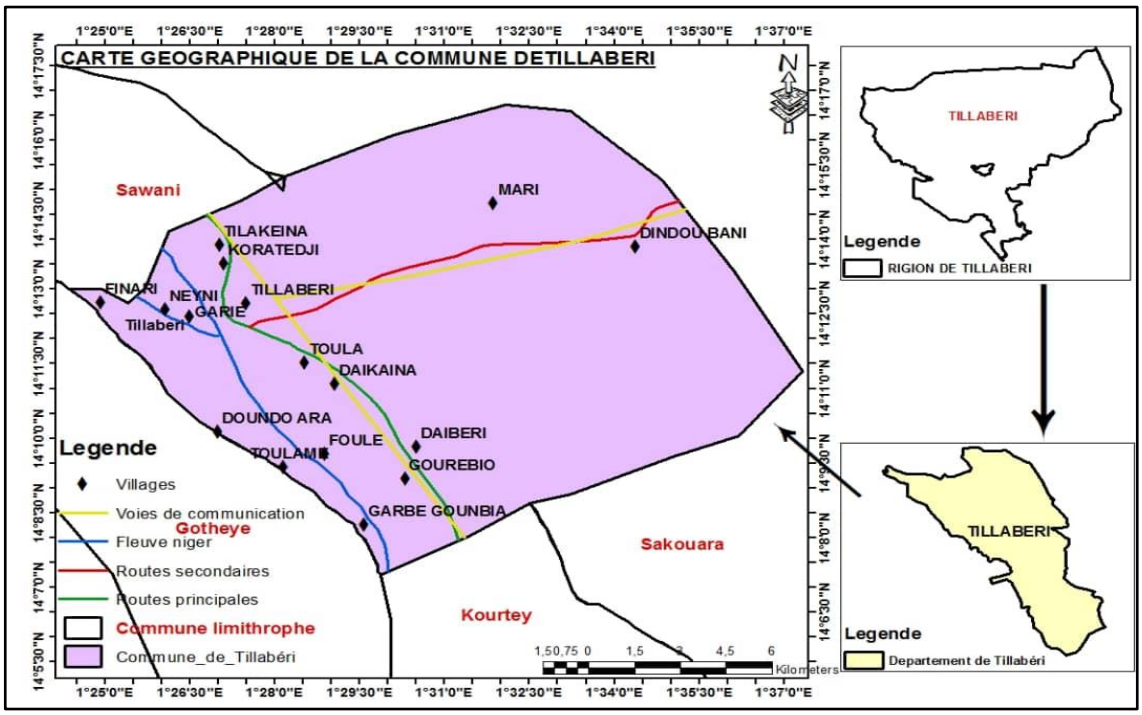

Figure 1 : **location map of the urban municipality of tillaberi (Loukmane, 2021)**

2.1.2. Study Site and Duration:

The study was conducted at the University's experimental site located in the urban commune of Tillabéri and lasted five (5) months, from 10 July to 10 December 2022.

2.1.3. Biological materials:

L'étude a concerné neufs chèvres du sahel (8 femelles et 1 bouc). Ces animaux qui avaient subi un élevage intensif, étaient gardés seules dans une maison close. Ils ont néamoins reçu un traitement antiparasitaire à base d'albendazole 2%., Les femelles ont servi à l'étude des paramètres de la reproduction et le mâle à la détection des chaleurs (Tableau 1). La repartion par categorie est reporté dans le tableau ci-dessous.

Table 1: Distribution of Goats into categories

2.1.4.

Category of caprirns	Primiparous goats	Multiparous goats	**Goat**	Total
Effectifs	4	4	1	9

Technical equipment:

The technical equipment used consists of :

- Non-marker apron for heat control ;
- Heat control sheets,
- numbered buckles for easy identification of the animals, containers.
- Cotton wool, tweezers, tanks.
- Scissors

FIGURE 2: SYRINGES; NUMBERED LOOPS, SCISSORS, PLIERS (Altiné, 2022).

2.1.5. Pharmaceutical Materials:

2.1.5.1 Albendazole 10%:

Albendazole oral suspension (10%) has been used for deworming of animals

Figure 2 : Albendazole 10% (Altiné, 2022).

1.1.5.2 Vaginal sponges:

Impregnated with progesterone, they are packaged in plastic bags, at a rate of 25 per bag, and then stored in a dark and dry place. They are marketed under the name "chronogest CR", white in colour, cylindrical in shape and with a thread at one end to allow their removal at the end of the treatment, dosed at 40 mg. The fluogestone acetate incorporated in the vaginal sponges is a synthetic progestagen that simulates the luteal phase of the cycle. The sponge thus ensures that terminal follicular growth and ovulation are blocked for the duration of the treatment. Vaginal sponges are applied using a goat-specific applicator (disinfect the applicator between each goat). Check that the sponge is still in place at the time of hormone injection. For goats1 , the following sponges are available: Syncro-Part 45 mg (Ceva) or Chronogest Chèvres LC 20 mg (MSD Santé Animale) with a waiting period for the delivery of milk for the latter (36 h from sponge application)

Figure 3 : VAGINAL SPONGE (Altiné, 2022).

2.1.5.3. Applicator : It consists of a hard plastic tube with a smooth surface. The front end of this tube is bevelled with a pusher that serves to propel the sponge into the vagina.

Figure 4 : applicator (Altiné, 2022).

2.1.3. Livestock management:

2.1.3.1. Feed:

The feed is essentially composed of herbaceous plants collected from the fields, leaves and pods of woody plants combined with concentrates. The concentrates (cereal bran, sometimes meal) are given to the animals at night (four kilograms).

Figure 5 : GOAT FEEDING (woody, bran, green grass) (Altiné, 2022).

2.1.3. 2. Watering:

Water is given morning and evening every day.

Figure 6: Abbreuviating2.1.3.3. Housing:

The goats are kept in the goat house, where three sheds are used as shelter from the rain and sun. In addition, there is a large woody tree used as a shelter and whose leaves and pods are also used to feed the goats. The figure below shows the animal housing and the feed storage shed.

Figure 7 : ANIMAL HOUSING AND FEED STORAGE SHED (Altine, 2022).

2.1.6. Individual animal heat monitoring form (see Annex):

The beginning of heat is notified by the sign (X) and the time noted
- The end of heat is notified by the sign (.) and the time noted
- Each heat period is coded by a number

2.2. Methods:

2.2.1. Technique for applying vaginal sponges:

- The sponges were placed in the goats from 27/09/2022 (in the morning).
- First, we chose 4 sponges impregnated with a progestagen, fluorogestone acetate (FGA) (45 mg, Synchropart® Ceva). We prepared them and put the necessary quantities in a plastic bag.
- The sponge was placed in the applicator at the non-bevelled end while being inserted through the untied side and pushed with the pusher.
- the goats were immobilised when the sponges were introduced.
- we carefully introduced the applicator into the animal's vagina and then released the sponge at the bottom of the vagina by pushing on the pusher.
- The plunger was held in place and the tube was pulled back a few centimetres to release the sponge. We finally removed the tube and plunger from the vagina.
- When placing the sponge we made sure that the wire was visible from the outside to facilitate its removal.
- After the break, the goats are kept quiet.
- We disinfected the applicator with a disinfectant solution (D2 and water) before and after each use.

The photos below illustrate the installation of the vaginal sponge.

Figure 8 : installation of the sponge in the applicator (Boutheyna, 2019<u>**2.2.2. Injection of PMSG**</u>:

The most commonly used doses for adult females vary between 400 and 700 International Units (IU) in the off-season, 300 and 600 IU in the sexual season. For this experiment we used 400 IU. As soon as the sponges are removed, the 'Folligon 400 IU' is injected at a rate of 0.5 ml of PMSG per goat, by deep intramuscular injection in the leg or neck. The PMSG injection should be given 48 hours before sponge removal.

<u>2.2.3. Removal of sponges</u>:

The removal of the sponges took place on 06/09/2022, day 11. To remove the sponge, the string should be pulled slowly downwards. If the string is not visible, look for it inside the vulva. Used sponges should be disposed of promptly by incineration. Some sponges may contain vaginal discharge indicating vaginitis.

<u>2.2.4. Distribution of the experimental batches</u>:

We paid for eight goats and one billy goat, all in good shape. Two deworming treatments were carried out one week apart (on 09/08/22 and 16/08/22) to ensure that they were in perfect health. These goats were divided into two batches of four (4) goats each. The first batch of four multiparous goats underwent a heat induction and synchronization treatment using vaginal sponges impregnated with a progestagen, fluorogestone acetate (FGA) (45 mg Synchropart® Ceva) for a period of 11 days on 27/08/22. These goats were also given a dose of 0.50 mg PMSG on 06/09/22 i.e. 48 hours before sponge removal. The next batch of four primiparous goats received a first dose of 0.50 mg PMSG for each goat on day 1 (27/08/22) and a second dose of 0.50 mg PMSG on day 11 (Tuesday 06/09/22).

Figure 9 : injection of the pmsg in im. and application of the vaginal sponge (altiné, 2022)

On day 12 the sponges are removed from batch 1 and the second dose of PMSG is administered to the second batch on day 11. 24 hours later a goat with a piece of cloth is introduced into the goats to identify those that are likely to express heat.

figure 10 : removal of the vaginal sponge (altiné, 2022)

2.2.5. Heat detection:

At the beginning of the experiment, we organised training sessions for the billy goats equipped with an overlap apron. This allowed us to retain one buck. The latter is used for heat control operations. Indeed, as Fabre-Nys (2000) pointed out, it is important that the bucks show a sufficient level of activity, which implies adequate preparation and an absence of aggressive interactions if several bucks are present together. Heat detection is carried out by exposing the females of both batches (goats and kids) twice a day to an aproned billy goat (photo 11) at 7:00 a.m. and 6:00 p.m. These sessions last for 1 hour each, with the billy goats being rotated between the two batches after 30 min. Immobility and acceptance of overlap by the male are taken as indicative of the onset of heat. Behavioural changes in the female are recorded at each heat event. Such a method has been used by Yénikoye (1986) on the Nigerian Peul ewe in Niger and Derquaoui et al. (1992) in Morocco on the D'man goat. The start and end times of heat are mentioned on the individual monitoring sheets (Appendix).

Figure 11 : bouc muni de tablier (altiné, 2022)

2.2.6. Data analysis and processing:

The processing and presentation of the data in the form of tables and figures was done in Excel

3. Results and Discussion:

3.1. Heat characteristics:

3.1.1. Signs of heat in females:The main signs of heat recorded in the female are reported in the table below (Table 2). The most important signs of heat are among others: Searching for the male and following his movements 100% positive, immobility when overlapping the male 100%, swelling and redness of the vulva 80%, lack of appetite 60%. Cervical mucus discharge was not observed in our experiment.

Table 2: Frequencies of characteristic heat signs in the Sahelian goat.

Signs of heat	Number of observations	Frequency (%)
Seeks the male and follows him in his movements	5	100
Tail wagging	2	40
Bleating	2	40
Immobility on overlap of the male	5	100
Overlapping of congeners	2	40
Aggression in relation to conspecifics	1	20
Lack of appetite	3	60
Swelling and redness of the vulva	4	80
Cervical mucus discharge	0	0

3.1.2. Observations of goat behaviour during the fight:

We have observed a number of behaviours as follows:

- Lighting
- The approach
- The flehmen

The goat urinates provocatively in the presence of a billy goat.

- Lack of appetite
- Stammering
- Overlapping of females and subsequent insemination by the billy goat.

Figure 12 : Approach (Altiné, 2022)

figure 13 : the goat teases the billy goat (atiné, 2022)

Figure 14 : Lighting (Altiné, 2022) **Figure 15 : The flehmen (Altiné, 2022)**

The photos below illustrate flaring and overlapping in goats.

Figure 16 : Lighting (Altiné, 2022). **Figure 17 : Overlap (Altiné, 2022)**

Females in heat approach the billy goat and tease it with their tails in constant motion. They sometimes isolate themselves from the group of animals to be sniffed. Then, after immobilisation, the female is mounted by the billy goat (after about 45 seconds). When there is no sire, the goat in heat allows herself to be ridden by the other females, so mucus is often discharged. The heat detection method used (bucks harnessed with protective aprons and an overlap observer) is classic as reported by Fabre-Nys (2000). For Vaillancourt and Lefebvre (2003), although the goat in estrus is more demonstrative, detection remains difficult and less accurate in the absence of a male. The use of several billy goats in rotation per control was intended to minimise the effect of the capricious behaviour that some females may display, namely refusing the approach of one billy goat and accepting the overlap of another (Fabre-Nys, 2000). The signs of heat described in the present work have been reported by many authors (Karimou, 2005; Hamidou, 1995; Fabre-Nys, 2000; Zarrouk et al., 2001). Tamboura et al (1998) consider that the basis for heat detection is essentially ethological, describing the behaviour of the female, agitation, acceptance of mounting, active search for the male, but also anatomo-histological, resulting in vulval swelling and mucus discharge. It should be noted that vulval discharge was not observed in our experiment.

3.2. Duration of estrus:

The table below describes the onset and cessation of heat recorded at the end of hormonal treatments.

Table 2: Statistics on the duration of heat observation

N°goat	Sponge withdrawal /Inj. (2nd PMSG)	Early heat	Duration	End of heat	Duration
04301	19/09/22 à 9 h00	20/.09 à 8 h15	23 h	22/09 à 17 h00	80 h
04302	06/09/22 à 8 h 30	07/09 à 13h30	29 h	08/09 à 20 h30	60 h
04305	19/09/22 à 9 h	Not heat	-	-	-
04306	19/09/22 à 9 h	Not heat	-	-	-
04303	06/09/22 à 8 h30	07 /09 à 10 h30	26 h	08/09 à 19 h00	32 h
0431 4	06/09/22 à 8 h30	07/09 à 10 h30	26 h	08/09 à 16 h00	55 h30
04318	23/09/22 à 8 h30	24/ 09 à 8 h00	23 h30	26 /09 à 18 h00	81 h30
04323	23/09/22 à 8 h30	Not heat	-	-	-
Means			16 h		39 h

Goats 04301 and 04302 came into heat respectively 23 h and 23.30 h after the end of the hormone treatment. Others came into heat 26 or 29 hours later. Goats 04305, 04306 and 04323 did not come into heat.

The average duration of oestrus in the Sahelian goat was 39 hours shorter than in the red goat of Maradi (43), taking into account the definitions of the beginning and end of oestrus given by Yénikoye (1986) and used in this study, 27±26.54 hours (Karimou 2005) is close to the average reported by Derivaux (1971) and Vaillancourt and Lefebvre (2003) which is 40 hours, but higher than that of the Mossi goat (Tamboura *et al.* , 1998) which is 20±2 hours and the Boer goat (Greyling, 2000) which is 37.4±8.6 hours. It is also higher than the result of Amadou (2013) on the Maradi red goat (26h02±20h30); it should be noted that for this author, the standard deviation is very high, which reflects large individual variability. The range of variation observed in nulliparous goats is in line with that reported by Zarrouk et al. However, in multiparous females, exorbitant estrus durations were obtained due to the existence of a female that can accept overlapping males for about 10 days.

3.3 Synchronisation rates achieved with the different protocols:

Table 3: Synchronised heat rates

Goats	Total headcount	Number of multi-pregnant goats in heat	Number of kids in heat	Total number of goats in heat	Percentage
Lot n°1	4	2	1	3	75%
Lot n°2	4	2	0	2	50%
Total	8	4	1	5	62,50%

The overall result was 62.50% heat induction in both batches. However, the estrus rate obtained in batch 1 was better, 75% positive response compared to 50% in batch 2. KANA et al (2008) used the same type of protocol in dwarf goats and found no difference between the two batches. 50% of animals responded positively to the treatment for each protocol. This difference in response was caused by the kids giving 0% positive response in batch 2 and 50% in batch

3.4. Frequency of heats observed according to the protocols

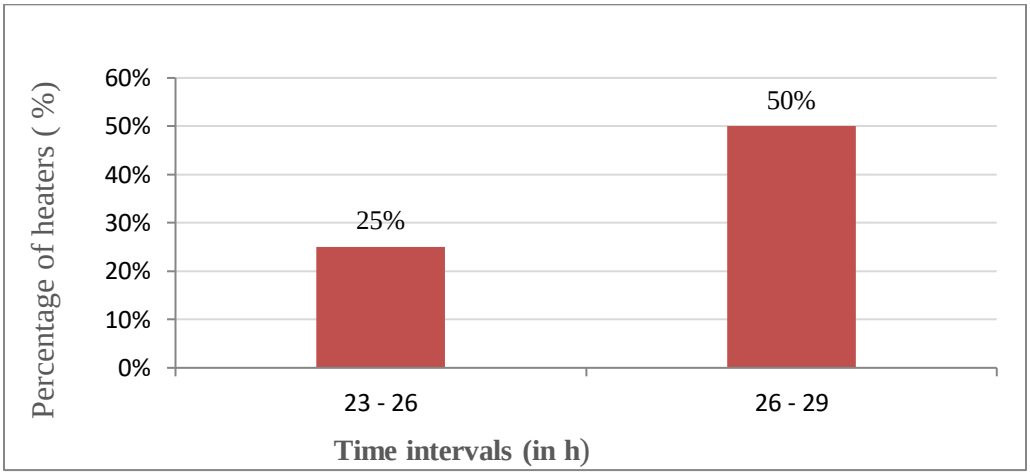

Figure 18 : % onset of heat as a function of time after removal of the vaginal sponge

25% of the goats came into heat between 23:00 - 26:00 and 50% between 26:00 - 29:00. Stopping the progestin simulates the end of the luteal phase. The removal of the sponge thus triggers terminal follicle growth and synchronous ovulation. The removal of the sponge is often combined with an injection of PMSG in order to increase the proportion of females coming into heat and especially to increase the ovulation rate.

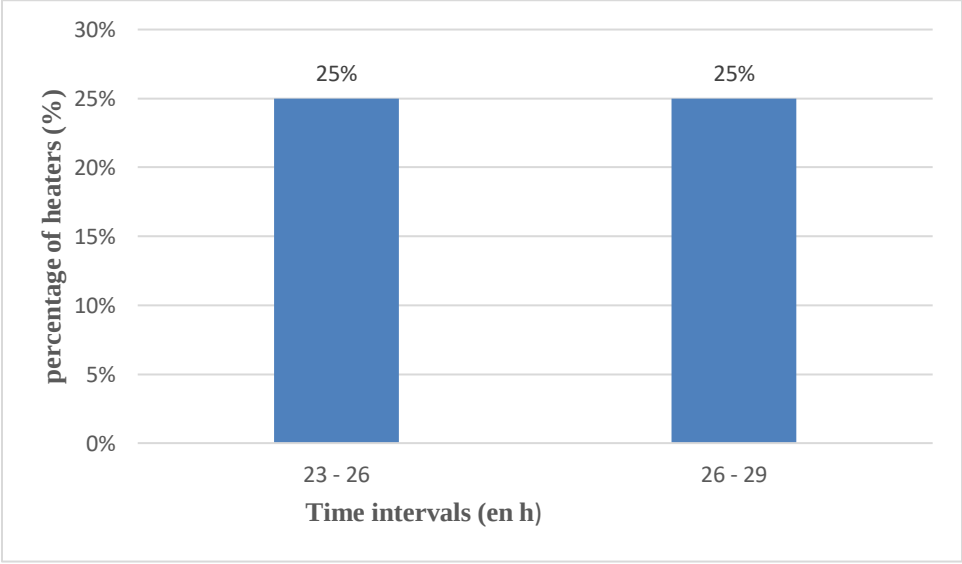

Figure 19 : % d'apparition des chaleurs en fonction du temps

After the 2 doses of PMSG 25% of the goats came into heat between 23h - 26h and 25% between 26h - 29h. The injection of PMSG hastens the onset of heat and the LH peak. In dairy goats outside the sexual season, an intramuscular injection of PMSG at the end of the progestin treatment (48 hours before withdrawal), increases follicular growth, duration of oestrus, ovulation rate and advances the onset of oestrus in treated females (Drion, 2001) which corroborates our results

CONCLUSION:

In view of the different results, the Sahelian goat responds fairly quickly and better to the heat induction and synchronisation treatment through the vaginal sponge-PMSG protocol than the PMSG protocol used alone. Also the multiparous animals give a better result 75% against 25% for the kids. These results point towards new perspectives. Therefore, the combination of two or more hormones seems to be more effective than the treatment with one hormone.

Rising incomes and rapid urbanisation are rapidly changing the eating habits in Africa in favour of high meat and milk consumption. The livestock sector plays a crucial role in ensuring food and nutrition security. It will support economic growth in the years to come. In order to meet the growing demand of the population for animal products, it is necessary to take stock of livestock production systems in general and goats in particular, and identify strategies for their development. Thus, we believe that controlling the seasonality of reproduction is important in goat farming in order to spread production throughout the year.

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