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Comparative study of heat induction in the red goat of Maradi by the use of extracts of local plant species

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Abstract

If in several countries of the world, artificial insemination is a common practice in the management of animal herds, it is not the same for many of the nations of the Sahelian African zone such as Niger where several factors complicate its development. One of the annoying situations would be the very high cost of the technique for the breeder. Thus, to reduce this cost related to the cost of heat-inducing hormones, this study aims to search for an alternative solution to the use of the artificial insemination technique which is very inaccessible to African breeders. This study involves first listing all plant species that induce heat in sheep-goats, and then testing their effectiveness in vivo in the Red goat of Maradi. The administration of a semi-closed questionnaire to a sample of 63 nomadic breeders from North Maradi made it possible to identify 81 plant species. These plant species are used either alone, in association or in a mixture with other non-plant products. Thus, the survey made it possible to list 71 heat-inducing recipes, 77% of which consist exclusively of plant extracts. The preselected goats were randomly divided into four comparable and different groups of 6 to 7 individuals receiving recipe R1 (group 1, n=7), recipe R2 (group 2, n=7), recipe R3 (group 3, n=7) and recipe R4 (control group, n=6). Two of these recipes, tested on two groups of goats, had allowed ≈ 42.85 and ≈ 57.14% to give birth against only ≈ 33.33% in the control group and 0% in the goats treated with pigeon droppings.

Thus, this study has made it possible to highlight a good knowledge of heat-inducing plants in goats by the nomadic population of North Maradi. It also revealed a trend in the effectiveness of the in vivo use of two of these plants in fertility in the Red goat of Maradi. This practice could constitute an alternative way to small ruminants' artificial insemination for breeders in sub-Saharan Africa.

Keywords: Red goat of Maradi; Heat induction; Fertility; Medicinal plants, Artificial insemination

1. Introduction

Niger is a big breeding country with small ruminants representing 63.54% of national livestock heads [1]. These animal species play a major role in the economy of the national household. Indeed, each year, 20% of goats and sheep are sold by rural households to cope with certain economic and social emergencies [2].

Despite their multiple functions in maintaining household food security, small ruminants are still exploited in traditional form, which does not allow their genetic potential to be exploited. To maximize the country's animal production in order to meet the growing demand for animal products from a galloping population, it is urgent to modernize Niger's livestock farming, particularly that of small ruminants. One of the main ways to improve these animal productions is the introduction of artificial insemination in goat and sheep herds which will undoubtedly facilitate the dissemination of

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the best genes. This insemination will assume above all a prior preparation of both parent; the male through seminal technology [3, 4, 5, 6, 7, 8, 9, 10] and the female by inducing heat [11, 12].

The main techniques of heat induction in small ruminants are the administration of luteolytic substances, progestagen, melatonin and the use of the male effect in the female. The first three methods are chemical compounds marketed by big laboratories and commercial firms in developed countries whose availability due to their high cost is still not assured in the countries of the South. On the other hand, the fourth method does not always guarantee good fertility results because of the presence of too short and/or long sexual cycles in the treated females [11]. Thus, if it would be necessary to facilitate the introduction of artificial insemination in sheep and goats in Niger, it would be interesting, among other things, to seek a technique which induces heat in these females at a lower cost and which can also preserve the environment more through, for example, the use of extracts of natural plants. Already, tests carried out on the basis of several plant organs by many teams of researchers around the world have made it possible to obtain very encouraging results on the induction of heat both in laboratory animals and also in domestic animals [13, 14, 15, 16, 17, 18, 19]. It is in this order of idea that the present study is done specially to set up a heat induction system in goats from plants harvested in Niger. This study essentially aims to list the different local plant species that induce heat in small ruminants and then to test the effectiveness of some of them in promoting heat induction in goats.

2. Material and methods

This study has two parts:

2.1. First Part

A first part dealing with the inventory of ethnobotanical knowledge used by breeders for the induction of heat in small ruminants. Thus, surveys using a semi-closed questionnaire were carried out among sixty-three nomadic herders in the department of Bermo, in the region of Maradi (south-central Niger), from October 29 to November 6, 2018.

Table 1 Composition of the different recipes administered to goats

Name in local languages Hausa /fulfuldé	Scientific name of the plant	Plant organ used	Recipe 1 (R1)	Recipe 2 (R2)	Recipe 3 (R3)	Recipe 4 (R4)
Dirga (g)	*Bauhinia rufescens*	Pods and leaves	130	300		
Farou (g)	*Lannea microcarpa*	Bark	108			
Dabino (g)	*Phoenix dactylife*	Pods	64			
Tafarnouwa (g)	*Allium sativum*	Bulbs	161			
Kimba (g)	*Xylopia aethiopica*	Pods	250			
Kabba (g)	*Hyphaene thebaica*	Young leaves	275			
Dachi (g)	*Commiphora africana*	Bark		79		
Dagna (g)	*Sclerocarya birrea*	Pods		333		
Pigeon droppings (g)					1 000	
Millet (g)	*Pennisetum glaucum (L.) R.Br.)*	Seeds				750
Licking salt (g)			250	250	250	250
Total (g)			1238	962	1250	1 000
Dose/animal/day(g)			10	10	10	10
Quantity of wheat bran/day (g)	*Triticum*	Bran	250	250	250	250

2.2. Second Part

A second part, which is devoted to the realization of an experimental design on the effectiveness of two recipes, the most cited by the respondents (R1 and R2) in the first part and a third recipe retained (R3) following a review literature on heat induction in animals. For this, a total of 26 adult and empty red goats, not showing signs of heat during the last 4 months (affirmed by the female owners), were considered in this study. The animals belonged to the women's groups of the Maradi red goat from the villages of "Matsachi" and "Samia-Koura", in the department of Tessaoua (Maradi's region). Thus, the goats were divided into 4 comparable and different groups of 7 or 6 individuals to receive recipes R1 (group 1, n=7), R2 (group 2, n= 7), R3 (group 3, n= 6) and R4 (control group, n=6). Each animal received daily the contents of its recipe in 250 g of wheat bran (Table 1) for 8 consecutive days.

Heat was detected twice a day (morning and evening), from the beginning of treatment until 10 days after the end of treatment, by the female breeders using whole bucks. The coupling is carried out by the same bucks that were used to detect the heat.

The parameters thus monitored were: the heat induction rate exhibited by the goats, the farrowing rate as well as the litter of each group of goats.

2.3. Statistical analysis

The necessary data was entered into an Excel 2013 sheet and the numerical frequencies of the different variables were determined. The comparison of farrowing rates between the different groups was carried out using the chi-square test (GraphPad Prism 8.1).

3. Results

3.1. Ethnomedical investigation of heat induction

The analysis of the survey results made it possible to identify 82 recipes used by breeders to improve productivity in small ruminants. Among these recipes, 87% are used to induce heat in ewes and goats and 13% are used to increase either the litter, or milk production, or the frequency of farrowing, or even to better protect the animals against evil (Figure 1). In addition, these different recipes are formulated from 105 ingredients, including 77% of vegetable origin, 20% of animal origin and 3% of other origins. These recipes are administered to animals by three types of routes: oral, topical and by fumigation which represent respectively, 87%, 12% and 1% of the total routes of administration used.

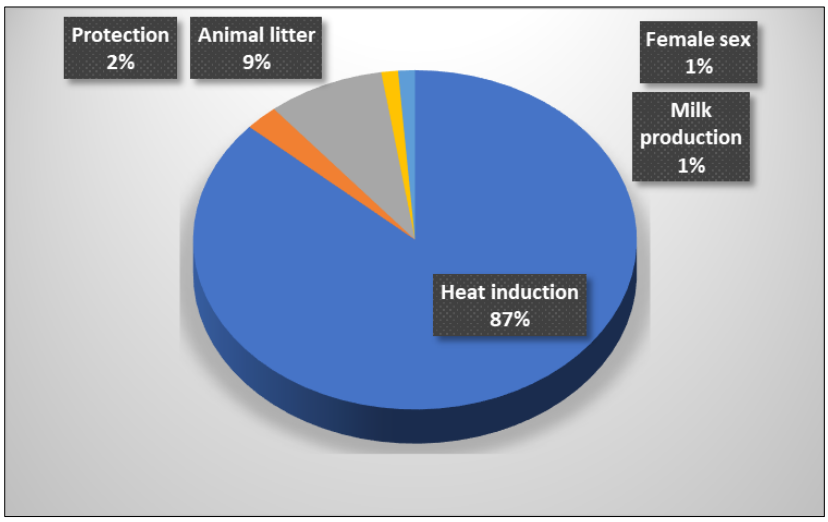

Figure 1 Purpose of listed recipes

The plants most cited and used in the heat-inducing recipes by the respondents were mainly *Bauhinia rufescens* and *Commiphora african* with a diversity of frequency distribution (Table 2). In addition, the animal products most used in the constitution of the recipes were especially the larvae of amphibians (*Bufo bufo*), milk from the goat (*Capra aegagrus*), the tongue of the lizard (*Agama agama*) and the placenta of the sow (*Sus scrofa domesticus*)(Table 3).

Table 2 List of the most repeated plants in recipes

Name in local languages Hausa /Fulfuldé	Scientific name of the plant	Number of times repeated in all recipes	Number of times repeated in heat induction recipes
Dirga	*Bauhinia rufescens*	24	23
Dachi	*Commiphora african*	16	13
Hatchi	*Pennisetum glaucum (L.) R.Br.)*	12	3
Danya	*Sclerocarya birrea*	9	8
Ibbé	*Ficus spp.*	7	5
Magariya	*Ziziphus mauritiana*	6	6
Waké	*Vigna ungulata*	6	0
Dabino	*Phoenix dactylifera*	5	5
Gujiya	*Arachis hypogaea*	5	4
Albasa	*Allium cepa*	5	2
Kalgo	*Piliostigma reticulatum*	4	3
Sabara	*Guiera senegalensis*	2	2
Balasa	*Commelina forskalaei*	2	2

Table 3 List of the most frequently used animal products in recipes

Animal			Number of times repeated in all recipes	Number of times repeated in heat induction recipes
Organ or stage of development used	Common name	Scientific name		
Larva	Toad	*Bufo bufo*	15	15
Milk	Goat	*Capra aegagrus*	7	7
Tongue	Lizard	*Agama agama*	6	6
Placenta	Sow	*Sus scrofa domesticus*	5	4
Placenta	Donkey	*Equus asinus*	2	2
Placenta	Goat	*Capra aegagrus*	2	2

3.2. Administration of heat-inducing recipes

In the presence of the buck, it was detected 14.28%; 71.42%; 0% and 83.33% of goats in heat with recipes R1, R2, R3 and R4 respectively. And according to the answers given by the women breeders, we noted the induction of heat in the goats between the 1st and the 13th day after the start of the treatment.

In addition, five months after the start of the introduction of bucks in the different groups, a farrowing rate of approximately 42.85%; 57.14%; 0% and 33.33% was noted for the groups of goats having received recipes R1, R2, R3 and R4 respectively. The average range was respectively 1.33; 1.5 and 1 for goats belonging to groups R1, R2 and R4, respectively.

4. Discussion

Surveys of 63 breeders identified 82 types of ethnobotanical recipes with a heat-inducing effect. This demonstrates the high level of traditional knowledge presented by these resource persons in the management of reproduction in their herds. Also, the fact that the main ingredients contained in these recipes consist mainly of plant organs (77%) indicates a certain mastery of reproduction through the traditional pharmacopoeia by this nomadic population. This justifies the validity of many studies carried out previously in order to show the decisive role that plant extracts can play in the resolution of fertility problems in both male and female laboratory animals and domestic animals. These include extracts of *Tribulus terrestris* administered daily to sheep at an individual dose of 1.5 g for 40 days which have improved the viability of sperm stored at 37 °C [20]. In addition, it was also demonstrated that extracts of *Moringa oleifera* seeds [21], *Xylopia aethiopica* fruits [22] and *Aloe vera* [23] had significantly improved libido and spermatogenesis of treated rats. Moreover, in the same laboratory specie animal, the administration of extracts of *Cnestis ferruginea* (Connaraceae) especially at a dose of 50 mg/kg of body weight resulted in an increase not only in the duration of estrus, in the weight of the ovaries and the uterus, but also in serum concentrations of hormones FSH, LH and estradiol [24]. In the same way, Benie [13] observed that extracts from the trunk bark of *Afrormosia laxiflora* (Papilionacea), Pterocarpuserinaceus (Papilionacea) and *Cola nitida* (Sterculiacea) induce ovulation in rats.

In the present study, the plant extracts used allowed 42.85 to 57.14% of goats to give birth on average in comparison not only with the control group where only 33.33% of animals gave birth, but also of the group of goats treated with powder from the droppings of pigeons where no female had given birth. It is important to note that in terms of heat induction it was the goats in the control group that showed more heat (more than 80%). This observation is contrary to the results on farrowing. These results reveal that farrowing rate is not necessarily correlated with heat induction in red goats. Moreover, the results of this work confirm the tendencies of the beneficial effect of plant extracts observed by many works on the induction of heat and the improvement of fertility in animals. Thus, in a study carried out in 2006, [25] had observed that 54.54% of cows in anestrus treated with the homeopathic cocktail containing *Calcarea phosphorica, Aletris farinosa*, Pulsatilla, *Aurum muriaticum* natronatum, Sepia and Phosphorus, had calving compared to 0% of cows in the control group. Later in 2016, [26] obtained 51.51% of pregnant ewes following a treatment based on extracts of *Aegle marmelos* and *Murraya koenigii* against 16.7% of pregnant females that had not been treated. In buffalo, extracts of *Aegle marmelos* and *Murraya koenigii* have also been shown to be very effective not only for heat induction but also for the improvement of fertility with 75% and 33.33% of induced heat and 75% and 50% of pregnant females, respectively for the treatment and control batches [18]. With regard to the goat species, the work carried out by [15] showed that the combination of plant extracts from *Murraya koenigii* and *Aegle marmelos* improves the fertility of goats in anoestrus. Because, according to these same authors, it made it possible to induce heat in 85% of treated goats, of which 83.33% remained pregnant after their mating against only 14.29% of goats in the control group who showed heat.

The mechanism by which these plant extracts improve the reproductive behavior of animals is not well understood. Nevertheless, it can be imagined that the stimulation of the hypothalamic-pituitary axis represents the most probable way of action of these plant extracts.

5. Conclusion

Surveys of the nomadic population have shown the existence of a panoply of recipes traditionally used by breeders to increase the presence of heat in small ruminants. These recipes are generally developed from the organs of medicinal plants and administered orally to females to allow the appearance of heat during the two weeks following the start of treatment. Regarding the recipes based on plant extracts administered to animals, they showed a good trend in improving the fertility of goats in anestrus. Nevertheless, further studies are needed to optimize their doses as well as to elucidate their mechanisms of action on animal reproduction.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

All experimental protocols and animal care were approved by the scientific and ethical Committee of UDDM on animal experimentation as established by the Decree N° 033/UDDM/RECT/SG of May 24, 2022.

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