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Original Article

Inventory of medicinal plants used in the treatment of diseases that limit milk production of cow in Benin

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ABSTRACT

Objective: This study aimed to make an inventory of animal diseases that affect milk production and the plants locally used against these diseases.
Materials and methods: A survey was carried out from April to August 2013 in 41 farms in department of Collines, 40 in Alibori, 40 in Borgou and 21 in Mono using questionnaires. SAS software was used with *Chi*-square test and bilateral Z test.
Results: The study revealed twelve main pathologies that limit milk production. Among these pathologies, foot-and-mouth disease and trypanosomiasis were the most mentioned pathologies. To fight these pathologies, 60 medicinal plants of 32 families were recorded. The most cited families were *Leguminosae* (31.67%), *Combretaceae* (6.67%), *Meliaceae* (5%) and *Rubiaceae* (5%), whereas the predominant species used by animal keepers were *Khaya senagalensis*, *Vitellaria paradoxa*, *Parkia biglobosa* and *Securidaca longipedunculata*. The 60 listed species were used in 85 recipes which varied from one department and farmer to another. The most used organs were plant barks (41.06%) and roots (31.13%), while the most common methods of preparation were decoction (37.5%), maceration (32.5%) and powders (22.5%). Oral route was the main route of administration.
Conclusion: The inventory has shown that the important pathologies are foot-and-mouth disease and trypanosomiasis. This needs immediate actions. Barks and roots were the commonly employed plant organs used as infusion (decoction and maceration) and powder that farmers administer orally to animals. The harvest did not require a special season or time. Furthermore, farmers inherited most of these recipes from their parents and they use them because of their effectiveness.

CORRESPONDENCE

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KEYWORDS

Benin; Cattle; Investigation; Medicinal plants; Pathologies

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INTRODUCTION

In Benin, cattle husbandry is mostly practiced in traditional systems (sedentary or transhumant) and faces serious challenges regarding the improvement of the production which relies on the health of the animals (Youssao et al., 2013). Therefore, investments are essentially directed towards the improvement of the health of these animals, particularly the supply of vaccines, drugs, as well as feed supplements (Bierschenk et al., 2004). Animal diseases have the potential to reduce significantly all animal productions (meat, milk, skin, etc). Of these products, milk is of paramount importance because it constitutes a basic food for farmers in rural areas (Sow Dia et al., 2007) and their main source of income. Besides, different dairy products are processed and are part of the domestic consumption.

Several animal diseases that affect their productivity were diagnosed in Benin. These include cowdriosis (Farougou et al., 1998; Farougou et al., 2012a; Farougou et al., 2013); bovine fasciolosis caused by *Fasciola gigantica* (Assogba and Youssao, 2001), trypanosomiasis (Doko Allou et al., 2010; Farougou et al., 2012b) and bovine brucellosis (Adehan et al., 2005). To relieve the pains of the farmers, a particular attention must be paid to diseases that affect animal productivity.

Efforts are made by governments through the livestock services of the Regional Agricultural Centres for Rural Development (CARDER) and veterinary offices. These livestock and veterinary services usually support farmers through vaccination campaigns and the treatments of pathologies using veterinary drugs. However, there are serious challenges related to the use of these products regarding their availability, accessibility and cost, as well as potential resistance cases. In situations like these, some farmers use endogenous practices for the improvement of health and to boost the milk production of their dairy cows. Such endogenous knowledge are not well known by the public and deserve to be documented for a better valorisation. The objective of this study was to contribute to the control of animal diseases with negative impact on milk production of cattle farms by establishing a database of traditional remedies.

MATERIALS AND METHODS

Study area: Data were collected in the departments of Alibori (Gogounou), Borgou (Parakou and Tchaourou), Mono (Comé and Athiémé) and Collines (Dassa-Zoumè) (**Figure 1**).

The department of Alibori is located in the North-East of Benin between 10°49'60" and 11.86° of North latitude and 2°25'60" and 3°41'40" of East longitude. It has a surface of 26242 km² (23% of the national territory). The climate and vegetation are of dry tropical type with one rainy season (May to October) and one dry season (November to April). The rainfall varies between 900 and 1200 mm. Soils are of ferruginous type with concretions. The vegetation is a high savannah dominated by *Parkia biglobosa*, *Vitellaria paradoxa*, *Khaya senegalensis*, *Adonsonia digitata* and kapok trees (Adam and Boko, 1993).

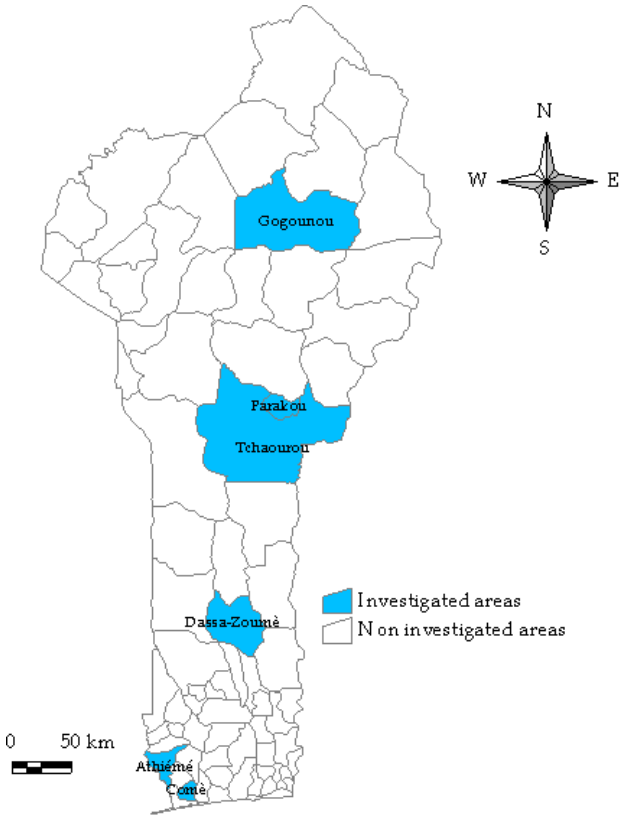

Figure 1. Areas of the present study.

The department of Borgou is situated in the North-East of Benin between 8°52'60" and 10°25'60" North latitude and 2°36'0" and 3°41'40" East longitude. It covers a surface of 25856 km² including 13962 km² of arable land being 54% of the total surface of the department. The climate is of humid Soudan type with great northern influences (harmattan) and an alternation of one rainy season (May to October) and one dry season (November to April). The average rainfall is 1200 mm. Soils are ferruginous with concretions and covered by tropical dry forests and high savannah (Adam and Boko, 1993).

The department of Mono is found in Southern Benin and characterized by a subequatorial climate with two rainy seasons: one big from April to July and a small one from September to November. These two seasons are separated by dry seasons. The average annual rainfall is about 1200 mm with hydromorphic soils on vases and alluviums. They are covered with shrubby fallows and palm trees.

The department of Collines is located in central Benin and characterized by two rainy seasons separated by two dry seasons. This region is a zone of transition between the subequatorial climate and the humid Soudan climate with contrasted seasons. It covers a surface of 13 561 km2. The average annual rainfall is about 1200 mm. The soils are ferruginous with concretions covered by a bushy savannah but also made of shea tree and other tropical trees.

Materials used: The used material was composed of questionnaires, a digital camera and cattle. The questionnaires were used to probe information on identification of the farmers, diseases that influence milk production, existing prophylactic plans and medicinal plants as well as recipes used for the treatment of these diseases.

Data collection: Face to face interviews were conducted to collect data from farmers. Information were collected on the farmers as well as on the traditional practices used for the treatment of animal pathologies in their farms. Respondents were selected based on their accessibility and availability to provide the required information. Data were collected from April to August 2013 in 41 farms in the department of Collines, 40 in Alibori, 40 in Borgou and 21 in Mono. A digital camera was used to take pictures of the medicinal plants found during the investigations. Some plant organs were sampled and used along with the photographs for the identification of the plants at the Laboratory of Botany and Applied Ecology of the National Herbarium of Benin.

Ethical statement: Ethical approval was not needed as we did not manipulate any animal.

Statistical analyses: Data were encoded in Excel and analysed with SAS software (SAS, 2006). Proportions were calculated per department with the Proc freq procedure of SAS (2006) and compared using Chi-Square test and bilateral Z test. For every relative percentage a confidence interval (CI) was calculated at 95% according to the formula below:

$$IC = 1,96\sqrt{\frac{[P(1-P)]}{N}}$$

Where, *P* is the relative percentage and N the sample size

RESULTS

The presence of diseases that influence milk production was reported by all farmers in the departments of Alibori and Collines, while 97.50% and 90% of farmers from Borgou and Mono respectively reported having had such diseases in their herds. There was no significant difference between these proportions ($P>0.05$). The cited diseases are numerous and include: foot-and-mouth disease, pasteurellosis, scabies, brucellosis, contagious bovine nodular dermatosis, digestive problems (enterotoxemia), conjunctivitis, contagious bovine peri-pneumonia (CBPP), mastitis, trypanosomiasis, pneumonia and dermatophilosis (**Table 1**). Foot-and-mouth disease (FMD) was reported in all the four departments with proportions of 100%, 94.87%, 74.29% and 42.11%, respectively in Mono, Collines, Alibori and Borgou. The proportions of farmers who reported the presence of foot-and-mouth disease in Mono and Collines were significantly higher than those in Alibori that was also higher than the proportion in Borgou ($P<0.001$). Contagious bovine nodular dermatosis, enterotoxemia, conjunctivitis, pneumonia and dermatophilosis were only reported in Collines in respective proportions of 17.95%, 7.69%, 2.56% and 2.56%. Pasteurellosis, scabies and mastitis were only recorded in Alibori and Borgou without significant difference ($P>0.05$) for Pasteurellosis. However, mastitis was more frequent in Alibori than in Borgou (45.71% Vs 5.26%; $P<0.05$). Brucellosis and CBPP were reported in the same proportions in the departments of Alibori, Borgou and Collines ($P>0.05$). Nevertheless, trypanosomiasis were more frequent in Alibori and Collines than in Borgou ($P<0.05$). Overall, foot-and-mouth disease and trypanosomiasis were the dominant pathologies in every investigated department. When these diseases occur, all farmers of the four departments declared to treat their animals using veterinary medicines, traditional medicines or the combination of both. In the departments of Alibori, Borgou and Collines, treatments are based on combination of modern and traditional veterinary drugs while in Mono modern veterinary medicine was the predominant method of treatment. The proportion of farmers that use modern veterinary medicine associated with traditional medicine in Alibori was significantly higher than those of Borgou and Collines which were higher than the one of Mono

Table 1. Diseases that limit milk production

Variables		Alibori			Borgou			Collines			Mono			Significance test
		N	%	CI	N	%	CI	N	%	CI	N	%	CI	
Presence of diseases that limit milk production	Yes	38	100a	0.00	40	97.50a	4.84	40	100a	0.00	20	90a	13.15	NS
	No	38	0.00a	0.00	40	2.50a	4.84	40	0.00a	0.00	20	10a	13.15	NS
Diseases that limit milk production	Foot-and-mouth disease	35	74.29b	14.48	38	42.11c	15.70	39	94.87a	6.92	14	100a	0.00	***
	Pasteurellosis	35	48.57a	16.56	38	34.21a	15.08	39	0.00b	0.00	14	0b	0.00	***
	Brucellosis	35	11.43a	10.54	38	18.42a	12.33	39	23.08a	13.22	14	0a	0.00	NS
	Scabeis	35	5.71a	7.69	38	5.26a	7.10	39	0.00a	0.00	14	0a	0.00	NS
	Contagious bovine nodular Dermatosis	35	0.00b	0.00	38	0.00b	0.00	39	17.95a	12.04	14	0ab	0.00	***
	Enterotoxemia	35	0.00a	0.00	38	0.00a	0.00	39	7.69a	8.36	14	0a	0.00	NS
	Conjonctivitis	35	0.00a	0.00	38	0.00a	0.00	39	2.56a	4.96	14	0a	0.00	NS
	CBPP	35	14.29a	11.59	38	5.26a	7.10	39	2.56a	4.96	14	0a	0.00	NS
	Mastitis	35	45.71a	16.50	38	5.26b	7.10	39	0.00b	0.00	14	0b	0.00	***
	Trypanosomiasis	35	71.43a	14.97	38	44.74b	15.81	39	74.36a	13.70	-	-	-	*
	Pneumonia	35	0.00a	0.00	38	0.00a	0.00	39	2.56a	4.96	14	0a	0.00	NS
	Dermatophilosis	35	0.00b	0.00	38	0.00b	0.00	39	17.95a	12.04	14	0ab	0.00	***
Treatment of diseases	Yes	38	100a	0.00	40	100a	0.00	40	100a	0.00	20	100a	0.00	NS
	No	38	0.00a	0.00	40	0.00a	0.00	40	0.00a	0.00	20	0a	0.00	NS
Mode of treatment	Veterinary drugs	38	2.70c	5.22	40	22.50b	12.94	40	30.00a	14.20	20	60a	21.47	***
	Medicinal plants	38	0.00a	0.00	40	0.00a	0.00	40	0.00a	0.00	20	5a	9.55	NS
	Veterinary drugs & medicinal plants	38	97.37a	5.09	40	77.50b	12.94	40	70.00b	14.20	19	36.84c	21.69	***
Person in charge of animals' treatment	Farmer	38	0.00a	0.00	40	2.50a	4.84	40	0.00a	0.00	20	5a	9.55	NS
	Veterinarian	38	2.63c	5.09	40	2.50c	4.84	40	1750b	11.78	20	60a	21.47	***
	Veterinarian & farmer	38	97.37a	5.09	40	95.00ab	6.75	40	82.50b	11.78	20	35c	20.90	***

*Proportions of the same row followed by different letters, differ significantly at 5% ; * : P<0.05 ; ** : P<0.0 1 ; *** : P<0.001 ; NS : P>0.05 ; N : Number ; CI : Confidence Interval*

Table 2. Medicinal plants recorded for the treatment of pathologies that limit milk production

Family	Species
Anacardiaceae	*Mangifera indica*
Annonaceae	*Annona senegalensis*
Apocynaceae	*Thevetia neriifolia*
Asclepiadaceae	*Calotropis procera*
Balanitaceae	*Balanites aegyptiaca*
Bignoniaceae	*Kigelia Africana*
Bombacaceae	*Adansonia digitata* *Bombax costatum*
Cochlospermaceae	*Coclospermum sp*
Combretaceae	*Terminalia macroptera* *Terninalia glaucescens* *Pteleopsis suberosa* *Anogeissus leiocarpus*
Convolvulaceae	*Ipomea batatas*
Cucurbitaceae	*Momordica balsamina* *Momordica cylindrica*
Dioscoreaceae	*Dioscorea sp*
Euphorbiaceae	*Uapaca togoensis*
Lamiaceae	*Ocimum basilicum* *Hyptis suaveolens*
Leguminosae	*Acacia polyacantha* *Acacia hockii* *Acacia Senegal* *Albizia chevalieri* *Albizia zygia* *Parkia Biglobosa* *Prosopis africana* *Xeroderris stuhlmannii* *Erythrina senegalensis* *Pterocarpus erinaceus* *Vigna unguiculata* *Afzelia africana* *Burkea Africana* *Cassia sieberiana* *Detarium microcarpum* *Isoberlinia tomentosa* *Swartzia madagascariensis* *Tamarindus indica* *Piliostigma thonningii*
Loganiaceae	*Strychnos spinosa*
Loranthaceae	*Tapinanthus sp*
Malvaceae	*Gossypium arboreum*
Meliaceae	*Khaya senegalensis* *Trichilia emetica* *Pseudocedrela kotschyi*
Moraceae	*Ficus umbellate*
Olacaceae	*Ximenia americana*
Poaceae	*Sorghum vulgaris* *Sorghum sp*
Polygalaceae	*Securidaca longipedunculata*
Rubiaceae	*Mitragyna inermis* *Sarcocephalus latifolius* *Gardenia aqualla*
Rutaceae	*Citrus limon*
Sapotaceae	*Vitellaria paradoxa*
Solanaceae	*Capsicum annuum*
Verbenaceae	*Vitex doniana*
Vitaceae	*Cissus populnea* *Cissus quadrangularis*
Zingiberaceae	*Amomum melegueta*

(*P*<0.001). Traditional medicine is only used in Mono by 5% of the investigated farmers. Treatments are administered by veterinarians and farmers themselves in the departments of Alibori, Borgou and Collines while in Mono, it is mainly veterinarians who take care of animals' treatments. The proportion of farmers that treat their animals by themselves differs significantly in the departments (*P*<0.001).

Plants used in the treatment of some pathologies

The study revealed 60 medicinal plants of 32 families (**Table 2**). The main families were *Leguminosae* (31.67%), *Combretaceae* (6.67%); *Meliaceae* (5%) and *Rubiaceae* (5%). Plant species mostly used by farmers in their recipes were *Khaya senagalensis*, *Vitellaria paradoxa*, *Parkia biglobosa* and *Securidaca longipedunculata*. The commonly used organs were: the barks (41.06%), the roots (31.13%), the leaves (12.58%), the fruits (7.95%) and the stems (7.28%). Most farmers used them as decoction (37.5%), maceration (32.5%) or powder (22.5%). Other modes of preparation were fumigation (3.75%), rubbing (1.25%), bark extracts (1.25%) and ointment (1.25%). The main mode of administration was the oral route but nasal (fumigation) and cutaneous routes were reported by some farmers. A total of 85 recipes were recorded for the treatment of 16 different pathologies (**Table 3**). They include 18 recipes for the treatment of snakebites, 12 against foot-and-mouth disease, 11 in the treatment of pasteurellosis and trypanosomiasis, 8 against brucellosis, 5 for placental retention, 4 for diarrhoea and fever, 3 for deworming, 2 to combat nodular dermatosis and agalactia and 1 recipe against scabies, mastitis and eye worms. These recipes varied from one department another and one respondent to another. Nevertheless, the use of *Calotropis procera* in the treatment of foot-and-mouth disease was reported in Borgou and Collines. Similarly, *Cissus populnea* was used against placental retention in two departments (Borgou and Mono). Farmers did not report conditions like snakebites, placental retention, nodular dermatosis, helminthoses among pathologies that limit milk production, but they treated these pathologies because of their importance. However, farmers did not mention or have any recipe that could be used against CBPP and Pneumonia.

Snakebites

The powder of the root and a maceration of the bark of *Vitellaria paradoxa* were used by 5 farmers in Collines and 2 from Borgou, respectively to treat snakebites. A decoction of the leaves of *Vitellaria paradoxa*, *Ipomoea batatas* and *Momordica cylindrica* was used by 2 farmers

Table 3. Traditional recipes used by farmers in the treatment of pathologies that limit milk production

Pathology	Plant	Used Organ	Mode of preparation	Lenght of treatment (day)
Agalactia	*Gardenia aqualla +Vigna unguiculata*	Root and seed	Powder	3.5
	Vigna unguiculata + Thevetia neriifolia +Calotropis procera	Seed and leaves of the 2 others	.	Until recovery
Brucellosis	*Annona senegalensis + Khaya senegalensis*	Stem and bark	Powder	Until recovery
	Anogeissus leiocarpa + Gardenia aqualla +Annona senegalensis	Stem	Powder	Until recovery
	Anogeissus leiocarpa +Tamarindus indica	Root and leaves	Decoction	7
	Calotropis procera	Fruit	Maceration	3
	Gardenia aqualla	Stem	.	.
	Isoberlenia tomentosa + Erythrina senegalensis	Bark	Maceration	3
	Khaya senegalensis + Securidaca longipedunculata+Adonsonia digitata+ sel	Leaves, leaves and bark	Powder	Until recovery
	Parkia biglobosa + salt	Fruit	Powder	3
Dermatophilosis	*Burkea africana* +ash	Leaves	Maceration	3
Contagious bovine nodular Dermatosis	*Ficus umbellata*	Stem	Powder	1
	Mitragyna inermis + Sorghum vulgaris+Terminalia glauscenss + cow urine	Root	Decoction	Until recovery
Diarrhoea	*Momordica balsamina* + Potash	Stem and leaves	Maceration	Until recovery
	Securidaca longipedunculata + Parkia biglobosa	Root and bark	Powder	3
	Terminalia macroptera + Parkia biglobosa + Albizia chevalieri	Bark, bark and root	Decoction	7
	Ximenia americana	Root	Maceration	2
Snakebites	*Afzelia africana*	Root	.	.
	Annona senegalensis	Root	Maceration	3
	Citrus limon+ Essence	Fruit	Ointment	1
	Khaya senegalensis	Root	Powder	3
	Prosopis africana	Bark	Maceration	1
	Sarcocephalus lotifolius	Root	Maceration	2
	Securidaca longipedunculata	Root	Maceration	.
	Securidaca longipedunculata + head of viper	Root	Powder	3
	Securidaca longipedunculata + Trichilia emetica + Pteleopsis suberosa	Roots of the 3	Maceration	2.5
	Securidaca longipedunculata+Vitellaria paradoxa	Roots of the 2	Powder	2
	Trichilia emetica	Root	Maceration	1
	Trichilia emetica+Securidaca longipedunculata+head of viper+Amomum melegueta	Roots of the 2	Powder	2
	Vitellaria paradoxa	Root	Powder	2
	Vitellaria paradoxa	Bark	Maceration	.
	Vitellaria paradoxa + Securidaca longipedunculata + Trichilia emetic	Roots of the 3	Maceration	2
	Vitellaria paradoxa + Trichilia emetica	Roots of the 2	Maceration	3
	Vitellaria paradoxa +Ipomoea batatas + Momordica cylindrica	Bark, root and leaves or fruit	Decoction	1
	Vitellaria paradoxa +Ipomoea batatas + Acacia hockii	Bark, root and leaves	Decoction	.
Fever	*Afzelia africana*	Bark	Decoction	9
	Afzelia africana + Parkia biglobosa	Bark+seed	Decoction	5
	Bombax costatum +Ocimum basilicum	Bark and leaves	Powder	7
	Pteleopsis suberosa	bark	Decoction	5.5
Foot-and-mouth disease	*Capsicum annuum*	Fruit	Maceration	Until recovery
	Citrus limon + Dioscorea sp + Salt	Leaves and peelings	Powder	1.5
	Citrus limon + Salt	Leaves	Powder	7
	Gossypium arboreum	Fruit	.	3
	Hyptis swavealens + chicken droppings	Leaves	Fumigation	7

	Parkia biglobosa + faeces of donkey	Bark	Maceration	3
	Pterocarpus erinaceus	Sap or Fruit	Rubbing	Until recovery
	Tamarindus indica + *Sorghum sp*	Stem	Maceration	Until recovery
	Tapinanthus sp + Salt	Leaves	Powder	Until recovery
	Terminalia glauscenss + *Acacia senegal*	Root and bark	Maceration	7
	Vitellaria paradoxa	Bark	Maceration	Until recovery
	Vitellaria paradoxa + *Gossypium arboreum*+ duck and chicken faeces	Stem and seed	Fumigation	.
Scabies	*Dioscorea sp*	Tuber	Maceration	Until recovery
	Khaya senegalensis + Potash	Bark	Decoction	2
Digestive Helminthiases	*Prosopis africana* + *Vitellaria paradoxa* + *Khaya senegalensis* + *Pseudocedrela kotschyi*	Bark	Decoction	7
	Sarcocephalus lotifolius	Leaves	Maceration	1.5
Indigestion	*Vitellaria paradoxa* + *Ximenia americana*	Bark and root	Decoction	7
Mastitis	*Gossypium arboreum* +bird nest	Seed	Fumigation	3
	Albizia zygia + *Strychnos spinosa*+ *Khaya senegalensis*	Bark	Decoction	Until recovery
	Khaya senegalensis	Root	Decoction	2.5
	Khaya senegalensis + *Kigelia africana*+ *Mangifera indica*+ *Albizia zygia*	Bark	Decoction	3
	Khaya senegalensis + Salt	Bark	Decoction or powder	Until recovery
	Khaya senegalensis+ *Kigelia Africana* + *Coclospermum sp* + Potash	Bark, bark and root	Decoction	7
Pasteurellosis	*Mangifera indica*+ *Khaya senegalensis*+ *Potash*	Bark of the 2	Decoction	7
	Parkia biglobosa	Root	Decoction	Until recovery
	Pterocarpus erinaceus + salt	Bark	Decoction	Until recovery
	Vitex doniana + *Khaya senegalensis* + *Detarium microcapum* + *Parkia biglobosa*	Root	Decoction	5.5
	Vitex doniana + *Khaya senegalensis* + Potash	Bark and root	Decoction	7
	Xeroderris stuhlmannii+ *Uapaca togoensis*+ Potash	Bark	Decoction	Until recovery
	Annona senegalensis + Potash	Leaves	Maceration	.
	Bombax costatum	Leaves	Powder	2
Placental retention	*Cissus populnea*	Root or stem	Decoction or maceration	1
	Cissus quadrangularis	Stem	Maceration	1
	Vitellaria paradoxa + Potash	Leaves	Maceration	1
	Afzelia africana	Bark	Decoction	Until recovery
	Balanites aegyptiaca + *vitellaria paradoxa*+ salt	Leaves and bark	Powder	3.5
	Bombax costatum	Bark	Decoction	-
	Dioscorea sp	Tuber	Maceration	Until recovery
	Khaya senegalensis + *Mangifera indica*+ *Burkea africana* +*Detarium microcapum*	Bark	Decoction	Until recovery
Trypanosomiasis	*Khaya senegalensis* + *Pseudocedrela Kotschyi* +*Vitellaria paradoxa* + *Parkia biglobosa*	Bark	Decoction	7
	Khaya senegalensis + *Pseudocedrela Kotschyi* +*Vitellaria paradoxa* + *Parkia biglobosa* + *Afzelia africana*+ Potash	Bark	Decoction	7
	Khaya senegalensis + *Pterocarpus erinaceus*	Bark	Maceration	7
	Khaya senegalensis + salt	Bark	Powder	7
	Khaya senegalensis+ *Cassia sieberiana* + *Swartzia madagascariensis* + *Acacia polyacantha*	Bark and root of the last 3	Decoction	4
	Ximenia americana + *Mangifera indica* + Potash	Root and bark	Decoction	2
Thelaziosis	*Piliostigma thonningii*	Bark	Juice extraction	Until recovery

In the column of used organs, the organs are listed based on the order of the cited plants of the recipes (e.g.: Root, bark and leaves means root of the first plant, bark of the second and leaves of the third

Table 4. Origin and drawbacks of traditional treatments applied to animal diseases that limit milk production

Variables		Alibori			Borgou			Collines			Mono			Significance test
		N	%	CI	N	%	CI	N	%	CI	N	%	CI	
Origin of the recipes used in traditional veterinary medicine	Inheritance from parents	37	91.89a	8.80	32	96.88a	6.02	32	90.63a	10.10	6	83.33a	29.82	NS
	Advice from colleagues	36	72.22a	14.63	32	18.75b	13.52	32	12.50b	11.46	6	33.33ab	37.72	***
	Knowledge of traditional healer	37	18.92a	12.62	32	0.00b	0.00	32	18.75a	13.52	6	0b	0.00	*
	Other sources	37	0.00b	0.00	32	0.00b	0.00	32	6.25ab	8.39	6	16.67a	29.82	*
Reasons of the use of medicinal plants to treat animals	Sociological reasons	37	86.49a	11.01	32	0.00c	0.00	33	36.36b	16.41	7	0c	0.00	*
	Accessibility	37	8.11b	8.80	32	31.25a	16.06	33	3.03b	5.85	7	57.14a	36.66	***
	Low cost	37	18.92a	12.62	32	3.13a	6.03	33	9.09a	9.81	7	14.29a	25.93	NS
	Effectiveness	37	94.59a	7.29	32	87.50a	11.46	33	57.58b	16.86	7	100a	0.00	***
Existence of drawbacks related to traditional treatments	Yes	38	0.00a	0.00	29	3.45a	6.64	36	2.78a	5.37	6	0a	0.00	NS
	No	38	100a	0.00	29	96.55a	6.64	36	97.22a	5.37	6	100a	0.00	NS

*Percentages of the same row followed by different letters, differ significantly at 5% ; * : P<0.05 ; ** : P<0.0 1 ; *** : P<0.001 ; NS : P>0.05 ; N : Number ; CI : Confidence Interval*

from the department of Collines to heal snakebites. Similar reports were obtained with the powder of the roots of *Khaya senegalensis*. Three farmers also used the powder of the roots of *Securidaca longipedunculata* and *Vitellaria paradoxa* to combat snakebites. Only one recipe made of the root of *Afzelia africana* and a maceration of the root of *Annona senegalensis* was recorded in Mono and Alibori, respectively. Maceration was the main mode of preparation adopted against snakebites in Alibori and Borgou. However, many methods such as powder (66.67%), decoction (16.67%), maceration (11.11%) and ointment (5.56%) were used in Collines. These treatments commonly last about 1 to 3 days.

Pasteurellosis

Recipes for the treatment of pasteurellosis were only recorded in Alibori and Borgou (**Table 3**). Moreover, 8 of the 11 recipes used against this pathology were based on *Khaya senegalensis* together with other plants or alone. A powder or a decoction of the bark of this plant was used with salt by 3 farmers in Borgou. Decoction was the main mode of preparation adopted by farmers against pasteurellosis in these two Departments. The length of treatment varied from 3 to 7 days, but some farmers don't have a precise idea of the length of treatment.

Foot and Mouth disease

There are a number of medicinal plants used to combat FMD (**Table 3**). Recipes used in the treatment of this pathology were recorded in three Departments (Alibori, Borgou and Collines). Only two farmers in Alibori treated this pathology clinically by applying a powder made of the leaves of *Citrus limon* and salt on the ulcers. The recipes varied from one Department to another except for the use of *Pterocarpus erinaceus* in Borgou and Collines. The modes of preparation were powder (75%) and maceration (25%) in Alibori and maceration (66.67%) and rubbing (33.33%) of the ulcers by the plant in Collines. In Borgou, the modes of preparation were maceration (33.33%), fumigation (33.33%), powder (16.67%) and rubbing (16.67%). The length of treatment ranged from 2 to 7 days.

Scabies, nodular dermatosis, eye worms and dermatophilosis

Recipes for the treatment of scabies and nodular dermatosis were recorded in Borgou and Collines, respectively (**Table 3**). Same applies to eye worms and dermatophilosis. Scabies were treated with a maceration of tubers of *Dioscorea sp*. For nodular dermatosis, farmers applied either a powder of the stem of *Ficus umballata* on the scabs, or a decoction prepared with the roots of *Mitragyna inermis*, *Sorghum bicolor* and *Terminalia glaucescens* in the urine of a cow. Bark extracts of *Piliostigma thonningii* were used against eye worms. A maceration of the leaves of *Burkea africana* was given to animals during 3 days to treat dermatophilosis.

Brucellosis

No recipe was reported against Brucellosis in the departments of Collines and Mono. However, 7 recipes were recorded in Borgou and one in Alibori (**Table 3**). The recipe used in Alibori was a powder of the fruits of *Parkia biglobosa* mixed with salt. Medicinal plants used in Borgou to combat Brucellosis were: *Annona senegalensis, Khaya senegalensis, securidaca longipendunculata, Adonsonia digitata, Anogeissus leiocarpa, Tamarindus indica, Gardenia aqualla, Calotropis procera, Isoberlenia tomentosa* and *Erythrina senegalensis*. The most used mode of preparation in Borgou was powder (50%), followed by maceration (33.33%) and decoction (16.67%). This disease is treated by plants for 3 to 7 days.

Placental retention

Recipes against placental retention were obtained in Alibori, Borgou and Mono. In Mono, the only plant used against this pathology was *Cissus populnea* used by only one farmer in the department. However, in Borgou, two farmers used it. The other plants used in Borgou were: *Cissus quadrangularis, Vitellaria paradoxa* and *Annona senegalensis*. These plants were used respectively by only one farmer either alone or together with potash. In Alibori, the plant used was *Bombax costatum*. The mode of preparation was powder in Alibori and maceration in Mono, while maceration (75%) and decoction (25%) were used in Borgou. The treatment is applied moistly only once.

Diarrhoea

Four recipes were reported for the treatment of diarrhoea including two in Alibori and two in Collines. Recipes used in Collines were each made of only one plant: *Momordica balsamina* for the first recipe and *Ximenia americana* for the second. The mode of preparation was maceration of either the stem or the leaves (*Momordica balsamina*) and the roots (*Ximenia americana*). In Alibori, the two recorded recipes were combinations of two or three plants in which *Parkia biglobosa* was always present.

The other plants were: *Terminalia macroptera* and *Albizia chevalieri* for the first recipe and *Securicada longipendunculata* for the second. The root and the bark of these plants were blended to make powder or decoctions. Cases of diarrhoea were treated by farmers during 2 to 7 days.

Trypanosomiasis

Medicinal plants were used in the treatment of Trypanosomosis by farmers of Alibori and Borgou. Recipes used against this disease varied from one farmer to another except for the use of the powder of the bark of *Khaya senegalensis* that was used by 3 farmers in Alibori. Three recipes made of *Detarium microcarpum, Dioscorea sp* and the association of *Khaya senegalensis, Mangifera indica* and *Burkea africana* were used in Borgou against this disease. In Alibori, 9 different recipes were used against Trypanosomosis (**Table 3**). *Khaya senegalensis* was essential used for all these recipes. The modes of preparation adopted in Alibori were decoction (50%), powder (40%) and maceration (10%). In Borgou, the modes of preparation were decoction (66.67%) and maceration (33.33%). These treatments last about 2 to 7 days.

Fever, mastitis, agalactia, digestive helminthiases

Four different recipes were reported by four farmers to combat hyperthermia in Alibori. These recipes were made of many plants of which *Bombax costatum, Ocimum basilicum, Afzelia africana, Parkia biglobosa* and *Pteleopsis suberosa*. The modes of preparation of these plants were powder (25%) or a decoction of the bark, the leaves and the stem (75%) (**Table 3**). Furthermore, conditions like indigestion problems and mastitis in Alibori, as well as agalactia in Borgou were treated with plants (**Table 3**). Helminthiases were also treated with medicinal plants in Alibori, Borgou and Mono. The recipe used against helminthiases in Alibori was an association of the Bark of *Prosopis africana*, *Vitellaria paradoxa*, *Khaya senegalensis* and *Pseudocedrela kotschyi*. In Borgou, helminthiases were treated with *Sarcocephalus lotifolius* and *Khaya senegalensis* with potash in Mono.

Plants harvesting time and season

The season and the time of plants collection were not important in the departments of Borgou, Collines and Mono. Nevertheless, some farmers of Collines reported that it is necessary to harvest *Securidaca longipedunculata* and *Vitellaria paradoxa* during the day for the treatment of snakebites. In Alibori, the season and the moment of plants collection were very important. In this department plants are harvested during the dry season and the day.

Origin and drawbacks of traditional treatments

In the department of Alibori, about 91.89% of farmers reported that traditional veterinary practices were inherited from parents, while 72.22% acquired these practices from colleagues and 18.92% affirmed that they are managed by traditional healers (**Table 4**). In Borgou, the majority inherited these practices from parents (96.88%), whereas only 18.75% acquired them from colleagues. The same tendencies were observed in Mono. However, 16.67% of respondents have other origins for the recipes that they used in the treatment of their animals. The majority (90.63%) of farmers from Collines inherited their recipes from their parents, 18.75% got them from traditional healers and 12.5% acquired the knowledge from friends while 6.25% reported undefined sources. Overall, most of recipes employed in the treatment of animals are inherited from parents in the four investigated departments, followed by those known from colleagues in the departments of Alibori, Borgou and Mono and recipes applied by a traditional healer in Collines. Recipes applied by traditional healers were only reported in Alibori and Collines.

The use of medicinal plants was justified by sociological reasons, accessibility and availability of the recipes, the low cost of the treatments and their effectiveness. The effectiveness of the treatments was the main reason of all farmers in all the investigated departments with significantly higher proportions in Mono (100%), Alibori (94.59%) and Borgou (87.50%) as compared to Collines (57.58%, $P<0.001$).

Next to the effectiveness of the treatments were sociological reasons in Alibori and Collines with significantly higher proportions in Alibori (86.49 vs 36.36%, $P<0.05$). The following reason for the use of medicinal plants was the accessibility of the products in Mono (57.14%) and Borgou (31.25%). With respect to the accessibility, these two proportions were significantly higher than those of 8.11% and 3.03% recorded in Alibori and Collines, respectively ($P<0.01$). The use of medicinal plants because of their low cost was the least mentioned reason in all investigated departments.

All respondents from Alibori and Mono declared that there are no drawbacks related to the use of medicinal plants for the treatment of animal diseases. Similar observations were made by majority of farmers in Borgou (96.55%) and Collines (97.22%). Nevertheless, 3.45% and 2.78% of farmers in Borgou and Collines, respectively found that the traditional treatments can present some

troubles. These inconveniences were diarrhoea in Borgou and treatment failures in Collines.

DISCUSSION

Diseases that limit milk production

Pathologies that limit milk production were reported with proportions that differ from one department to another. These diseases were: FMD, pasteurellosis, scabies, brucellosis, contagious bovine nodular dermatosis, digestive problems (enterotoxemia), conjunctivitis, contagious bovine peripneumonia (CBPP), mastitis, trypanosomiasis, pneumonia and dermatophilosis. Among these diseases, FMD and trypanosomiasis were predominantly present. According to farmers investigated in Botswana, the top six diseases were FMD, eye infections, diarrhea, pasteurollosis, phosphorisis and contagious abortion (Gabalebatse et al., 2013). Youssao et al. (2013) reported the presence of diarrhoea, rotten feet, abortions, coughing, scabies, lesions of stomatitis, fever, nasal discharges, pica, whimpering, wounds, weight loss and meteorism in cattle from Alibori, Atacora and Borgou. For Dehoux and Hounsou-Vê (1993), the main pathologies that are found in cattle are: trypanosomosis, bovine brucellosis, streptothricosis, tuberculosis, pasteurellosis, contagious bovine péripneumonia, Foot and Mouth Disease disease, gastro-intestinal parasitosis, bovine fasciolosis and rotten feet.

All the aforementioned diseases were treated in the investigated farms using veterinary drugs or medicinal plants or the association of both applied either by a veterinarian or the farmers themselves. This association of traditional medicine and modern veterinary medicine was previously reported in Borgou and Alibori by Youssao et al. (2013). Furthermore, Alkoiret et al. (2009) reported that farmers use local plants for prevention and treatment of some pathologies in Gogounou Municipality.

Plants used in the treatment of the enumerated pathologies

The present study revealed 60 plant species of 32 families used in the treatment of cattle diseases whereas Ninety-four plant species belonging to 50 plant families were mentioned by Disler et al. (2014). The main plant families were *Leguminosae*, *Combretaceae*, and *Rubiaceae* as also mentioned by Hilou et al. (2014) in Burbina-Faso. The implication of some leguminosae like *Fabaceae* in the treatment of animal pathologies was reported by Byavu et al. (2000) in Congo. In addition to *Fabaceae*, these authors reported *Asteraceae*, *Lamiaceae*, *Solanaceae* and *Euphorbiaceae* as plant families employed in the treatment of animal pathologies. Disler et al. (2014) also reported Plants belonging to the *Asteraceae* as the most frequently uses. Plants belonging to these different families were recorded in the present study but in low proportions. Studies conducted by Tamboura et al. (1998) in Burkina-Faso and by Chakraborty et al. (2012) in India also demonstrated a large diversity of medicinal plants used by farmers to treat their animals. Nwodo et al. (2015) have shown on their side in Nigeria some same plant families we've got in our study. The commonly used organs were: the bark, the roots, the leaves, the fruits and the stems. These different organs were reported by Tamboura et al. (1998), Byavu et al. (2000), Kubkomawa et al. (2013), and Chabi China et al. (2014). In Botswana, farmers usually utilise plant roots, barks and leaves in the treatment of animal pathologies (Gabalebatse et al., 2013). However, other plant organs such as flowers (Tamboura et al., 1998), bulbs and rhizomes (Toyang et al., 2007) and even the whole plant in the case of a herbaceae (Byavu et al., 2000) are used in traditional medicine. Mistakes committed when harvesting some of these organs can delay the regeneration of the plant leading to the extinction of some plant species (Dro et al., 2013). This is why urgent protective measures should be taken for the preservation of these plants (Dro et al., 2013). This concerns mainly the use of roots and barks. The massive use of the leaves and barks was reported in Burkina-Faso (Tamboura et al., 1998; Kabore et al., 2007), while the use of leaves, roots and fruits was described in Congo (Byavu et al., 2000). According to Tamboura et al. (1998), the massive use of leaves and barks can be explained by the fact that farmers are aware that these organs harbour high concentrates of the active substances of the plants. Moreover, these parts of the plants are easy to harvest, to prepare and to keep and remain available without threatening the survival of the plant (Tamboura et al., 1998).

Decoction, maceration and powder were the main modes of preparation and the oral route was the main route of administration. These three modes of preparation were also reported by Tamboura et al. (1998). The predominance of these modes of preparation can be due to their route of administration which is oral and easy. The recipes recorded in this study were 85 for 16 pathologies. These recipes varied according to individuals and the location. Nevertheless, some recipes were used by several people from different locations. This variability of recipes was observed in the studies of Tamboura et al. (1998), Byavu et al. (2000) and Kubkomawa et al. (2013).

The use of *Mangifera indica, Khaya senegalensis, Parkia biglobosa, Strychnos spinosa, Detarium microcapum* and *Pterocarpus erinaceus* in the treatment of pasteurellosis; *Ximenia americana* in the treatment of diarrhoea, *Cassia sieberiana, Afzelia africana* and *Khaya senegalensis* in the treatment of trypanosomiasis, *Vitellaria paradoxa* in the treatment of foot-and-mouth disease, *Prosopis africana* and *Khaya senegalensis* in the treatment of digestive helminthiases and *Vigna unguiculata* in the treatment of agalactia in the present study were previously described by Dassou et al. (2014) in Benin. Other plants such as *Bombax costatum* and *Khaya senegalensis* used in the treatment of placental retention and intestinal worms, respectively in this study were also reported by Tamboura et al. (1998) in Burkina-Faso. Similarly, *Securidaca longipedunculata* employed to heal snakebite was also described by Tchao and Komlan (2012) in West Africa. Two of the plants used against helminths (*Khaya senegalensis* and *Vitellaria paradoxa*) are also employed in Cameroon for the same purposes (Djoueche et al., 2011).

Furthermore, it was noticed that many traditional remedies used in Africa were also used in Southern America and Asia where sometimes the same plant is used for different treatments (Toyang et al., 2007). The present study revealed no recipe used against CBPP which farmers recognized as one of the pathologies that limit milk production. However, Dassou et al. (2014) reported the use of a decoction of the fruits of *Tamarindus indica* and the leaves of *Khaya senegalensis* and *Oxythenanthera abyssinica* against CBPP. Moreover, Bâ (1996) reported from farmers in Mauritania a recipe made of sick lungs that are left to be fermented for one or two nights in a mixture of millet bran soaked in water, fresh milk and *Acacia nilotica* for the treatment of CBPP. The lack of recipe regarding the treatment of CBPP in the current study is attributable to the mode of transmission of the information that is commonly from father to son which limits the spread of the knowledge to the rest of the family.

Plants harvesting time and season

In the departments of Borgou, Collines and Mono, there were no specific time and season to collect medicinal plants for the treatment of animal diseases. However, they are essentially collected during the dry seasons and in the day time in Alibori. According to Toyang et al. (2007), the best moment to harvest is the beginning or the end of dry seasons whereby most plant species begin to bloom. Besides, these authors advised to harvest plants in sunny mornings, so that they can be obtained dry. The season and time specified in Alibori are therefore in agreement with those reported by Toyang et al. (2007).

Origin and drawbacks of traditional treatments

Most of the recipes used by farmers in the treatment of their animals were inherited from parents in the four investigated departments, while some were obtained from colleagues mainly in Alibori, Borgou and Mono and a few were applied by traditional healers essentially in the department of Collines. This mode of transmission of knowledge can be due to the fact that pastoral parents wanted to make sure their children are well and fully trained to take good care of the herd. Many other authors (Bâ, 1996; Tamboura et al., 1998; Kabore et al., 2007; Kubkomawa et al., 2013) have also reported this same mode of transmission of knowledge. Furthermore, this knowledge is transmitted orally from generation to generation (Toyang et al., 2007; Kabore et al., 2007). Such father to son transmission of the knowledge leads to an appropriation of the practice by a certain family, social group or ethnic group (Bâ, 1996). Therefore, in case farmers don't have a particular knowledge, they always know the right person from whom to seek medication based on the condition that they need to treat (Bâ, 1986).

The reasons that justified the use of medicinal plants were: sociological reasons, the accessibility of the recipe, the low cost of treatments and the effectiveness of the treatments. The most important reason was the effectiveness of traditional treatments. According to Toyang et al. (2007), ethnoveterinary practices are easily accessible, cheap and effective, especially in rural areas where modern veterinary services do not exist or are irregular and expensive. Moreover, the safety and effectiveness of ethnoveterinary drugs depend solely on the experience of their use over time (Toyang et al., 2007). To validate this safety and effectiveness, farmers use the historical performances of the plants and their own daily experiences (Toyang et al., 2007).

Almost all farmers declared that the use of medicinal plants in the treatment of animal diseases present no drawbacks. This could be explained by farmers' ignorance regarding side effects and other inconveniences associated with the use of medicinal plants. However, there are a number of drawbacks associated with veterinary ethnomedecine. These include: risks of misdiagnosis, imprecise dosage, poor hygiene, mysteries around the healing process, and risks of treatment failure or dangerous treatments (Toyang et al., 2007).

CONCLUSION

The inventory of diseases that limit milk production and plants used against these diseases revealed a total of 12 important pathologies mainly foot-and-mouth disease and trypanosomiasis. Sixty different medicinal plant species were reported by farmers against these pathologies. Farmers inherited most of these recipes from their parents and they use them because of their effectiveness. However, pathologies like pneumonia and CBPP remained without traditional treatment. This calls for immediate actions from animal health workers regarding the importance of these pathologies.

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest with any other people or organizations in any financial or personal relationship

AUTHORS' CONTRIBUTION

IYAK and SF conceived the study and acquired the funding. NDN, ID, and SA coordinated the study design and carried out the field work, the analysis of the information and wrote the manuscript. All authors were involved in revising the manuscript and approved the final manuscript.

REFERENCES

1. Adam SK, Boko M (1993). Le Bénin, Les éditions du Flamboyant. Edicef: Paris; p 96.
2. Adehan R, Koutinhouin B, Baba-Moussa LS, Aigbe L, Agbadje PM, Youssao AKI (2005). Prévalence de la brucellose bovine dans les fermes d'Etat du Bénin de 2000 à 2003. Revue Africaine de Santé et Production Animales (RASPA), 3(3-4): 200-204.
3. Alkoiret TI, Awohouedji DYG, Akossou AYJ, Bosma RH (2009). Typologie des systèmes d'élevage bovin de la commune de Gogounou au Nord-Est du Bénin. Annales des Sciences Agronomiques du Bénin, 2(12): 77-98.
4. Assogba MN, Youssao AKI (2001). Epidémiologie de la fasciolose à *Fasciola gigantica* (Cobbold, 1885), de la dicrocoeliose et de la paramphistomose bovines au Bénin. Revue de Médecine Vétérinaire, 145: 260-268.
5. Bâ AS (1986). L'impact de la sécheresse sur le milieu pastoral sahélien. Agence de coopération culturelle et technique. Paris; p 76.
6. Bâ AS (1996). Passé, présent et perspectives de l'ethnomédecine vétérinaire africaine. Revue scientifique et technique (International Office of Epizootics), 15(3): 813-826. https://doi.org/10.20506/rst.15.3.960
7. Bierschenk T, Forster R, (2004). L'organisation sociale des peulh dans l'Est de l'Atacora (République du Bénin, Commune de Kouandé, PehoncoetKérou). Gutemberg University ; Arbeitspapiere / Working papers (46), Mainz; p 94.
8. Byavu N, Henrard C, Dubois M, Malaisse F (2000). Phytothérapie traditionnelle des bovins dans les élevages de la plaine de la Ruzizi. Biotechnology, Agronomy, Society and Environment, 4(3): 135-156.
9. Chabi China TF, Olounlade PA, Salifou S (2014). Ethnobotanical study of endogenous methods used for the treatment of diseases of Somba cattle breed in Northen Benin. Journal of Drug Delivery & Therapeutics, 4(3): 91-99.
10. Chakraborty S, Pal SK (2012). Plants for Cattle Health: a review of ethnoveterinary herbs in veterinary health care. Annals of Ayurvedic Medicine, 1(4): 144-152.
11. Dassou HG, Ogni CA, Yedomonhan H, Adomou AC, Tossou M, Dougnon JT, Akoegninou A (2014). Diversité, usages vétérinaires et vulnérabilité des plantes médicinales au Nord-Bénin. International Journal of Biological and Chemical Sciences, 8(1): 189-210. https://doi.org/10.4314/ijbcs.v8i1.18
12. Dehoux JP, Hounsou-Ve G (1993). Productivité de la race bovine Borgou selon les systèmes d'élevage traditionnels au Nord-Est du Bénin. World Animal Review, 74: 36-48.
13. Disler M, Ivemeyer S, Hamburger M, Vogl CR, Tesic A, Klarer F, Meier B, Walkenhorst M (2014). Ethnoveterinary herbal remedies used by farmers in four north-eastern Swiss cantons (St. Gallen, Thurgau, Appenzell Innerrhoden and Appenzell Ausserrhoden). Journal of Ethnobiology and Ethnomedicine, 10: 32. https://doi.org/10.1186/1746-4269-10-32
14. Djoueche CM, Azebaze AB, Dongmo AB (2011). Investigation of Plants Used for the Ethnoveterinary

control of Gastrointestinal Parasites in bénoué Region, Cameroon. Tropicultura, 29(4): 205-211.
15. Doko Allou S, Farougou S, Salifou S, Ehilé E, Geerts S (2010). Dynamique des infections trypanosomiennes chez des bovins Borgou à la ferme de l'Okpara au Bénin. Tropicultura, 28(1): 37-43.
16. Dro B, Soro D, Koné MW, Bakayoko A, Kamanzi K (2013). Evaluation de l'abondance de plantes médicinales utilisées en médecine traditionnelle dans le Nord de la Côte d'Ivoire. Journal of Animal &Plant Sciences, 17(3): 2631-2646.
17. Farougou S, Adakal H, Biguezoton SA, Boko C (2012a). Prévalence de l'infection d'Amblyomma variegatum par Ehrlichia ruminantium dans les élevages extensifs du Bénin. Revue de Médecine Vétérinaire, 163(5): 261-266.
18. Farougou S, Adakal H, Boko C (2013). Evaluation de la prévalence de la cowdriose chez les ruminants domestiques au Bénin. Revue de Médecine Vétérinaire, 164(12): 572-576.
19. Farougou S, Doko Allou S, Sankamaho I, Codjia V (2012b). Prevalence of Trypanosome Infections in Cattle and Sheep in the Benin's West Atacora Agro-ecological zone. Tropicultura, 30(3): 141-146.
20. Farougou S, Toguebaye BS, Tounkara K, Sy D, Akakpo JA (1998). Epidémiologie de la cowdriose au Benin : Etude préliminaire sur la présence du germe chez les tiques vectrices. Revue de Médecine Vétérinaire, 149(10): 953-958.
21. Gabalebatse M, Ngwenya BN, Teketay D, Kolawole DO (2013). Ethno-veterinary practices amongst livestock farmers in ngamiland district, Botswana. African Journal of Traditional, Complementary and Alternative Medicines, 10(3): 490-502. https://doi.org/10.4314/ajtcam.v10i3.16
22. Hilou A, Rappez F, Duez P (2014). Ethnoveterinary management of cattle helminthiasis among the Fulani and the Mossi (Central Burkina Faso): plants used and modes of use. International Journal of Biological and Chemical Sciences, 8(5): 2207-2221. https://doi.org/10.4314/ijbcs.v8i5.24
23. Kabore A, Tamboura HH, Belem AMG, Traore A (2007). Traitements ethno-vétérinaires des parasitoses digestives des petits ruminants dans le plateau central du Burkina Faso. International Journal of Biological and Chemical Sciences, 1(3): 297-304.
24. Kubkomawa HI, Nafarnda DW, Adamu SM, Tizhe MA, Daniel TK, Shua NJ, Ugwu CC, Opara MN, Neils JS, Okoli IC (2013). Ethno-veterinary health management practices amongst livestock producers in Africa- A review. World Journal of Agricultural Sciences, 1(8): 252-257.
25. Nwodo NJ, Ibezim A, Ntie-Kang F, Adikwu MU, Mbah CJ (2015). Anti-trypanosomal activity of nigerian plants and their constituents. Molecules, 20(5): 7750-7771. https://doi.org/10.3390/molecules20057750
26. SAS (1996). SAS/STAT User's guide, vers, 6, 4th ed, Cary, NC, USA, SAS Inst.
27. Sow Dia F, Somda J, Kamuanga M (2007). Dynamique des filières laitières en zone sahélienne : cas de l'offre et de la demande du lait en zone agropastorale centre du Sénégal. Revue d'élevage et de médecine vétérinaire des pays tropicaux, 60(1-4): 77-88.
28. Tamboura H, Kaboré H, Yaméogo SM (1998). Ethnomédecine vétérinaire et pharmacopée traditionnelle dans le plateau central du Burkina Faso : cas de la province du Passoré. Biotechnology, Agronomy, Society and Environment. 2(3): 181-191.
29. Tchao M, Komlan B (2012). Données ethnobotaniques et chimiques des plantes médicinales utilisées en Afrique dans les traitements traditionnels vétérinaires. Bulletin of Animal Health and Production in Africa, 60: 461-468.
30. Toyang NJ, Wanyama J, Nuwanyakpa M, Django S (2007). Ethnomédecine vétérinaire: une approche pratique du traitement des maladies du bétail en Afrique subsaharienne. Agrodok 44, ISBN CTA: 978-92-9081-370-5; pp 90.
31. Youssao AKI, Dahouda M, Attakpa EY, Koutinhouin GB, Ahounou GS, Toleba SS, Balogoun BS (2013). Diversité des systèmes d'élevages de bovins de race bovine Borgou dans la zone soudanienne du Bénin. International Journal of Biological and Chemical Sciences, 7(1): 125-146. https://doi.org/10.4314/ijbcs.v7i1.11

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