











Research Article

Traditional Herbal Medicine and its Prospects among Goat Breeders of Benin

Kétomon Pierre Challaton^{1,*} , Coovi Guénolé Akouedegni¹ , Goué Géorcelin Alowanou^{1,3} , Kadoéito Cyrille Boko² ,
Fréjus Tanguy Ablô Zinsou¹ , Amos Gilles-Christ Akakpo¹ , Abiodoun Pascal Olounladé^{1,4} , and Mawulé Sylvie
Hounzangbé-Adoté¹ 

¹ Laboratoire d'Ethnopharmacologie et de Santé Animale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Cotonou, Bénin

² Unité de Recherche sur les Maladies Transmissibles du Laboratoire de Recherches en Biologie Appliquée, Ecole Polytechnique d'Abomey-Calavi, Université d'Abomey-Calavi, Cotonou, Bénin

³ Laboratoire des Recherches Pluridisciplinaires de l'Enseignement Technique, Ecole Normale Supérieure de l'Enseignement Technique, Université Nationale des Sciences, Technologies, Ingénierie et Mathématiques, Abomey, Bénin

⁴ Laboratoire des Sciences Animale et Halieutique (LaSAH), Unité de Recherches Zootechnique et Système d'élevage, Ecole Doctorale des Sciences Agronomiques et de l'Eau, Université Nationale d'Agriculture, 01 BP 55 Benin

* **Corresponding author:** Ketomon Pierre Challaton, Laboratoire d'Ethnopharmacologie et de Santé Animale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Cotonou, Bénin. Email: pierrechallaton00@gmail.com

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ABSTRACT

Introduction: The use of traditional medicinal plants for the treatment of diseases in livestock farming is a common practice in Benin. Various ethnoveterinary studies have documented plants that livestock farmers use to treat animal diseases. However, these studies have been limited mainly to inventorying these plants, without exploring farmers' perceptions on the use of these plants to promote the sustainable use of medicinal plants. The current study aimed to fill this gap by gathering farmers' views on the use of traditional herbal medicines.

Materials and methods: A structured survey was conducted from February to April 2023 in the southern, central, and northern regions of Benin. This survey targeted 480 goat farmers who actively engage in veterinary phytotherapy practices. Data were collected through random individual interviews with farmers. The interviews focused on the socio-cultural characteristics of the farmers, their motivations for using medicinal plants, the different forms of preparation, the plant efficacy, the difficulties encountered when using them, and prospects for improvement using open-ended, multiple-choice, and yes/no questions.

Results: There were three distinct groups of goat farmers based on their opinions on the use of traditional herbal medicines and their socio-demographic characteristics. Group 1 consisted mainly of married and illiterate men. Group 2 was predominantly composed of married and educated men. Group 3 consisted mainly of married men, with a slightly higher illiteracy rate compared to Group 2. Group 1 used plants due to their easy accessibility and knowledge acquired since childhood, while groups 2 and 3 used them due to the high cost of conventional medicines and the perceived effectiveness of herbal medicine. Group 1 mainly used decoctions and powders, group 2 utilized powders, macerations, and trituration, and group 3 used raw preparations, decoctions, and macerations. All three groups agreed on the widely recognized efficacy of medicinal plants. Nevertheless, they encountered difficulties concerning conserving traditional herbal remedies and the imprecision of dosage. All three groups expressed a willingness to explore new forms of traditional herbal medicines, such as suspensions and tablets, prioritizing efficacy, availability, and affordability.

Conclusion: The results indicated that all three groups of goat breeders expressed a willingness to use herbal medicines. However, they prefer suspensions and tablets of herbal medicines rather than other forms. In addition, prioritizing efficacy, availability, and affordability are notable for using herbal medicine in current study farmers. These results offer prospects for improving traditional herbal medicines.

1. Introduction

The use of traditional herbal medicines to treat diseases in animal husbandry is a common practice in Benin.

Livestock farmers have long relied on medicinal plants to treat their animals for digestive parasites, constituting a

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form of traditional veterinary medicine¹. Numerous ethnoveterinary surveys have been carried out in various regions of Benin. These studies have documented the plants used by farmers to manage animal diseases, as well as their preparation procedure, administration methods, and treatment conditions²⁻⁶. Some of these plants have been the subject of scientific research and have proved effective, particularly against gastrointestinal parasites⁷⁻⁹. Given the efficacy of these medicinal plants, it would be interesting to develop improved traditional medicines (ITMs) to expand the possibilities of treatment and control of animal diseases. In order to formulate ITMs that are suitable for the needs of farmers, it is crucial to understand their motivations and perceptions regarding traditional herbal medicines. This approach facilitates a more integrated and tailored strategy toward animal health, accounting for the distinctive aspects of goat farming. However, it's noteworthy that existing ethnoveterinary studies in Benin have predominantly overlooked these aspects. Rather, they have primarily focused on cataloging the plants employed by farmers for treating their animals without deeply exploring farmers' viewpoints²⁻⁶. By seeking the views of livestock farmers on the use of traditional herbal medicines, it becomes feasible to develop future policies and programs that are better aligned with their needs and expectations. By integrating their perspectives into decision-making processes, it will be possible to promote the sustainable use of medicinal plants while considering the regional, cultural, and socio-economic specificities of each community of farmers. Furthermore, the evaluation of an innovation by a potential adopter depends on several characteristics of that innovation¹⁰, such as the needs, socio-economic status, and attitude of the adopter towards such changes¹¹. Therefore, the implementation process of an innovation is a

prerequisite for the success of its adoption. Within this context, this study aimed to explore the opinion of goat farmers in Benin regarding the use of traditional herbal medicines. It also sought to evaluate their potential need for newly improved forms of these medicines and their criteria for adopting these new forms.

2. Material and Methods

2.1. Ethical approval

The study involved gathering information on goat farmers' opinions on the use of medicinal plants to treat animal diseases following a study protocol evaluated and approved by the research and extension committee (University of Abomey-Calavi, Benin) and the responsible authorities where the work was carried out. No manipulations were carried out on either animals or humans during the data collection phase of the study. The interviewed breeders provided their consent for the collection of data.

2.2. Study area

The study was carried out from February to April 2023 in six departments of Benin. In northern Benin, the study took place in the departments of Alibori (11.33421° N, 2.90415° E), Atacora (10.69353° N, 1.58171° E) and Borgou (9.78836° N, 2.76648° E). Moving to central Benin, the department of Collines (8.12929° N, 2.20714° E) was included and in southern Benin the research covered the departments of Couffo (6.99643° N, 1.78289° E) and Zou (7.27465° N, 2.10861° E), targeting specific communes in each department. Colored plates on the map represent the study municipalities (Figure 1). The selection of

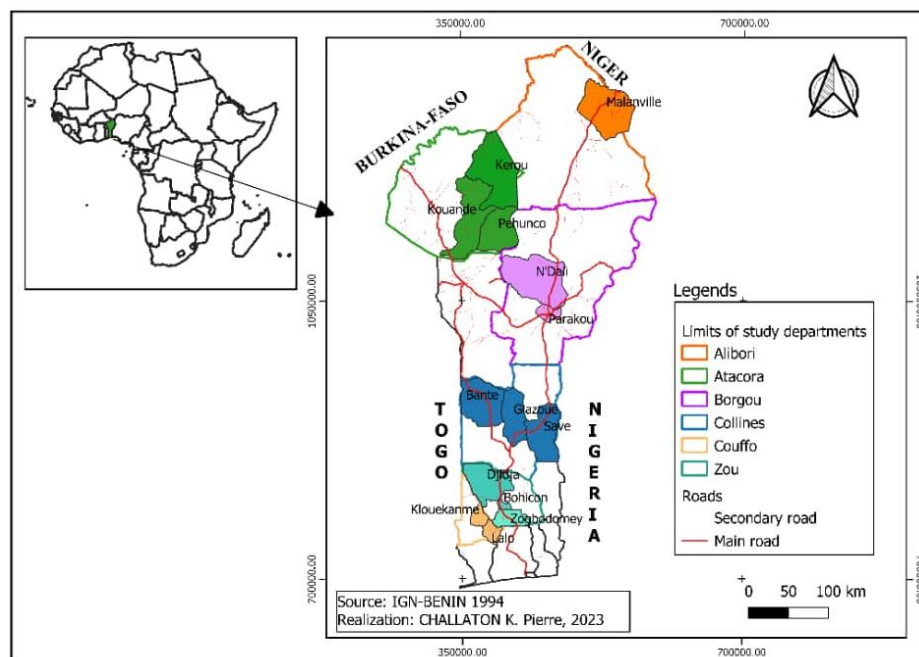


Figure 1. Map of Benin showing the study areas; colored plates on the map represent the study municipalities

departments and municipalities was based on the concentration of goat farming in these areas. In the Alibori department, only the municipality of Malanville was included due to its high concentration of Sahelian goat farming. In the Atacora department, the municipalities of Kérou, Kouandé, and Péhunco were selected, while in the Borgou department, the municipalities of Parakou and N'Dali were included. The municipalities of Glazoué, Savè, and Bantè were sampled in the Collines department, while the municipalities of Djidja, Zogbodomey, and Bohicon were chosen in the Zou department. For the Couffo department, the municipalities of Lalo and Klouékanmè were selected. These departments exhibit marked socio-cultural diversity. The department of Zou is mainly inhabited by socio-cultural groups predominantly made up of Fon ethnic groups, while in the department of Alibori, there is a diverse coexistence of various ethnic groups, notably the Bariba, Dendi, Fulani and their related communities. A similar cohabitation between Bariba and Fulani is also observed in the Atacora and Borgou departments. Adja and their relatives are mainly concentrated in the Couffo department, while Yoruba and their relatives are more present in the Collines department¹². As for literacy rates, they vary considerably from one department to another. The Mono department has the highest literacy rates, followed by Collines and Zou. On the other hand, the Alibori and Atacora departments have the lowest rates¹². The distribution of religions shows that Christianity predominates in the Collines departments, while traditional religions are mainly present in the Couffo, Zou, and Atacora departments. Islam, on the other hand, is concentrated in the Alibori and Borgou departments¹².

2.3. Data collection plan

The survey was conducted among goat farmers engaged in veterinary phytotherapy. In each study commune, 30 goat farmers were randomly selected, resulting in 480 surveyed farmers across 16 sampled communes. The data collection process was performed by developing a structured questionnaire. Prior to implementation, this questionnaire underwent rigorous pre-testing and adaptation. The collected data included the socio-cultural characteristics of the farmers, their motivations for using medicinal plants, the different forms of medicinal plant use, perceived effectiveness, challenges encountered during their use, and prospects for improvement. Information on the socio-demographic characteristics of the breeders was also collected. The data were gathered through individual interviews based on the pre-established survey form with open-ended, multiple-choice, and yes/no questions. The surveyed farmers were informed prior to the visit, allowing them to prepare the requested information.

2.4. Statistical analysis

The data collected during the current study was recorded and stored in a database created using Excel software. A Hierarchical Cluster Analysis (HCA) combined with Multiple Correspondence Analysis (MCA) was

conducted to group the surveyed farms based on the use of medicinal plants and their perceived outcomes. Specifically, MCA was performed using the 'MCA' function from the 'FactoMineR' package¹³. The variables considered for this analysis included department, gender, marital status, level of education, occupation, ethnicity, motivations for using plants, outcomes after use, forms of administration, and challenges related to plant use. Subsequently, HCA was performed using the 'HCPC' function from the same package. Frequencies followed by 95% confidence intervals (CIs) were calculated using the formula below for the selected variables within each group, and then compared between the groups using a prop.test at a 5% significant level. In order to establish the relationship between ease of preparation and the different drug forms, a correspondence analysis (CA) was carried out using the "CA" function from the "FactoMineR" package¹³. All analyses were conducted using R 4.1.1 software¹⁴.

$$CI = 1.96 \times \sqrt{\frac{p(1-P)}{N}}$$

Where, P is the proportion, N denotes the sample size, and CI refers to the Confidence Interval.

3. Results

3.1. Classification of surveyed breeders

The obtained results of MCA revealed that three axes, each representing the proportion of variances retained for this dimension (axe), that were chosen to effectively elucidate the observed variation (inertia) in the data. Thus, these three axes accounted for 18.22% of the observed total variation, with 7.68% for the first axis, 5.74% for the second axis, and 4.80% for the third axis (Figure 2). The three studied groups of caprine breeders exhibited significant differences in relation to each other ($p < 0.05$). In Group 1, consisting of breeders from the Alibori, Atacora, and Borgou departments, there was a majority of married (96.61%) and illiterate men (70.34%), with over half belonging to the Fulani ethnicity. In Group 2, breeders from the Collines and Zou departments, there was a

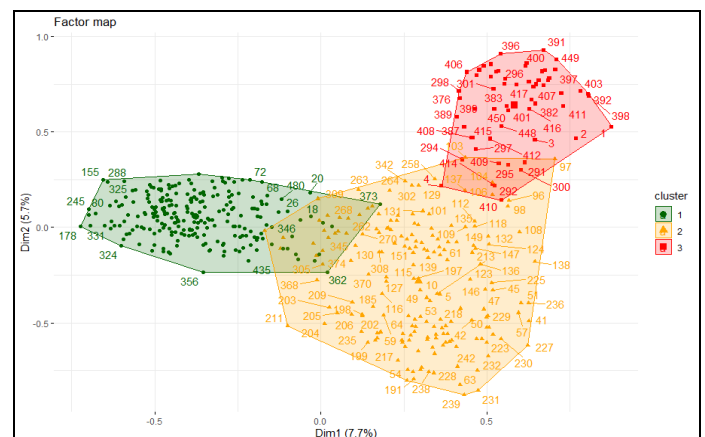


Figure 2. Distribution axes of the surveyed goat breeders surveyed from February to April 2023 in Benin, Green, yellow, and red colors represent breeders in clusters 1, 2, and 3, respectively.

Table 1. Socio-cultural characteristics of goat breeders surveyed from February to April 2023 in Benin

Variables	Modalities	Group 1			Group 2			Group 3			Z-test
		N	(%)	CI	N	(%)	CI	N	(%)	CI	
Department	Alibori	90	38.14a	6.20	0	0.00b	0.00	0	0.00b	0.00	***
	Atacora	89	37.71a	6.18	1	0.54b	1.06	0	0.00b	0.00	***
	Borgou	57	24.15a	5.46	3	1.63b	1.83	0	0.00b	0.00	***
	Collines	0	0.00a	0.00	90	48.91b	7.22	0	0.00a	0.00	***
	Couffo	0	0.00a	0.00	0	0.00a	0.00	60	100b	0.00	***
	Zou	0	0.00a	0.00	90	48.91b	7.22	0	0.00a	0.00	***
Gender	Female	12	5.08a	2.80	40	21.74b	5.96	4	6.67a	6.31	***
	Male	224	94.92a	2.80	144	78.26b	5.96	56	93.33a	6.31	***
Marital status	Single	7	2.97a	2.17	22	11.96b	4.69	6	10b	7.59	**
	Divorced	1	0.42a	0.83	6	3.26b	2.57	0	0a	0.00	*
	Married	228	96.61a	2.31	150	81.52b	5.61	51	85ab	9.04	***
	Widowed	0	0.00a	0.00	6	3.26b	2.57	3	5b	5.51	**
Education (Yes/No)	No	166	70.34a	5.83	76	41.30b	7.11	33	55ab	12.59	***
	Yes	70	29.66a	5.83	108	58.70b	7.11	27	45ab	12.59	***
Education	Illiterate	166	70.34a	5.83	76	41.30b	7.11	33	55.00ab	12.59	***
	Primary	44	18.64	4.97	42	22.83	6.06	12	20.00	10.12	NS
	Secondary I (First cycle)	10	4.24a	2.57	30	16.30b	5.34	8	13.33b	8.60	***
	Secondary II (Second cycle)	9	3.81a	2.44	23	12.50b	4.78	5	8.33ab	6.99	**
	Higher I (Bachelor's degree)	6	2.54	2.01	12	6.52	3.57	2	3.33	4.54	NS
	Higher II (Master)	1	0.42	0.83	1	0.54	1.06	0	0.00	0.00	NS
Profession	Administrator (Primary school)	3	1.27	1.43	2	1.09	1.50	0	0.00	0.00	NS
	Agro-livestock farmer	137	58.05a	6.30	6	3.26b	2.57	20	33.33b	11.93	***
	Artisan	1	0.42	0.83	4	2.17	2.11	0	0.00	0.00	NS
	Trader	18	7.63a	3.39	47	25.54b	6.30	4	6.67a	6.31	***
	Driver	0	0.00	0.00	2	1.09	1.50	0	0.00	0.00	NS
	Farmer	16	6.78a	3.21	101	54.89b	7.19	29	48.33b	12.64	***
	Student	0	0.00	0.00	3	1.63	1.83	0	0.00	0.00	NS
	Exclusive breeder	59	25.00a	5.52	2	1.09b	1.50	6	10.00b	7.59	***
	Teacher	1	0.42a	0.83	15	8.15b	3.95	0	0.00a	0.00	***
	Worker	0	0.00	0.00	2	1.09	1.50	0	0.00	0.00	NS
	Veterinarian	1	0.42	0.83	0	0.00	0.00	1	1.67	3.24	NS
	Adja	2	0.85a	1.17	2	1.09a	1.50	47	78.33b	10.42	***
	Dendi	5	2.12	1.84	1	0.54	1.06	0	0.00	0.00	NS
Ethnicity	Fon	10	4.24a	2.57	89	48.37a	7.22	12	20.00b	10.12	***
	Otamari	13	5.51a	2.91	0	0.00b	0.00	0	0.00b	0.00	**
	Peulh	161	68.22a	5.94	13	7.07b	3.70	0	0.00b	0.00	***
	YaoLokpa	8	3.39a	2.31	0	0.00b	0.00	0	0.00b	0.00	*
	Yoruba	37	15.68a	4.64	79	42.93b	7.15	1	1.67c	3.24	***
Training in livestock farming	No	231	97.88a	1.84	174	94.57ab	3.27	53	88.33b	8.12	**
	Yes	5	2.12a	1.84	10	5.43a	3.27	7	11.67b	8.12	**
Type of livestock farming	Semi-intensive	7	2.97a	2.17	1	0.54a	1.06	7	11.67b	8.12	***
	Traditional	229	97.03a	2.17	183	99.46a	1.06	53	88.33b	8.12	***

Group 1: Cluster 1, Group 2: Cluster 2, Group 3: Cluster 3, CI: Confidence interval, N: Number, NS: Not significant ($p > 0.05$), *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$, Frequencies on the same line, followed by the same letters, are not significantly different at the 5% threshold.

dominance of married (81.52%) and primarily educated men (22.83%), with a majority having completed primary education and belonging to the Fon and Yoruba ethnicities. Group 3, on the other hand, primarily comprised married men (85.00%) with a slightly higher illiteracy rate (55.00%) and mostly belonging to the Adja and Fon ethnicities. Breeders in Group 1 primarily practiced agro-

livestock (58.05%), while those in Groups 2 (54.89%) and 3 (48.33%) were mainly engaged in agriculture (Table 1). The predominant forms of use also varied among the groups, with decoctions (90.25%), powders (48.31%), and fresh leaves (43.22%) for Group 1, powders (51.09%), fresh leaves (39.67%), macerations (38.59%), and triturations (33.7%) for Group 2, and fresh leaves

Table 2. Forms of traditional herbal medicine usage by goat breeders surveyed from February to April 2023 in Benin

	Group 1			Group 2			Group 3			Z-test
	N	(%)	CI	N	(%)	CI	N	(%)	CI	
Decoction	213	90.25a	3.78	76	41.3b	7.11	28	46.67b	12.62	***
Infusion	5	2.12a	1.84	18	9.78b	4.29	0	0.00a	0.00	***
Maceration	6	2.54a	2.01	71	38.59b	7.03	22	36.67b	12.19	***
Powder	114	48.31a	6.38	94	51.09a	7.22	5	8.33b	6.99	***
Trituration	48	20.34a	5.14	62	33.7b	6.83	21	35b	12.07	**
Freshness (Fresh leaves)	102	43.22a	6.32	73	39.67a	7.07	44	73.33b	11.19	***
Poultice/rubbing	72	30.51	5.87	47	25.54	6.30	20	33.33	11.93	NS
Fumigation	58	24.58a	5.49	3	1.63b	1.83	0	0.00b	0.00	***

Group 1: Cluster 1, Group 2: Cluster 2, Group 3: Cluster 3, CI: Confidence interval, N: Number, NS: Not significant ($p > 0.05$), ***: $p < 0.001$, Frequencies on the same line, followed by the same letters, are not significantly different at the 5% threshold.

(73.33%), decoctions (46.67%), macerations (36.67%), and trituration (35.00%) for Group 3 (Table 2). Regarding perceived efficacy, more than half of the breeders in each group (67.37% in Group 1, 75.00% in Group 2, and 55.00% in Group 3) testified to the effectiveness of medicinal plants (Table 3). The encountered difficulties were mainly related to the preservation of plant-based medicines (37.29% in Group 1, 64.67% in Group 2, and 98.33% in Group 3), but breeders in Group 1 also highlighted issues of scarcity and imprecise dosage, while those in Group 2 and Group 3 focused primarily on preservation (Table 4). Regarding the motivations for using medicinal plants, Group 1 relied on their easy and cost-effective accessibility, lifelong familiarity, and the value placed on traditional pharmacopeia. In Groups 2 and 3, the high cost of conventional medicines (79.35% and 95%, respectively) and the recognized efficacy of traditional remedies were the primary reasons for their use (Table 5).

3.2. Conditions treated and difficulties in using different forms of plants

Cataplasms/rubbing are widely used to treat skin-related issues, such as wounds, eczema, and dermatosis. This form of preparation involves applying a paste made from crushed or ground plants directly to the affected area. On the other hand, fumigation is preferred for

treating ectoparasites, such as ticks and fleas. Fumigation involves using the smoke of certain plants to treat ectoparasites. Various forms of preparation are used for digestive (diarrhea and gastrointestinal parasites) and respiratory conditions such as cough, bronchitis, and nasal discharge, including decoctions, infusions, macerations, powders, triturations, and fresh leaves (crude). Among these, liquid preparations are orally administered to goats (Figure 3). All these preparation forms of traditional herbal medicines are relatively easy to prepare and administer, except for fresh leaves (crude), which can be more or less challenging to administer (Figure 4).

3.3. Willingness to explore new forms of traditional herbal medication and acceptance criteria of users

The results indicated a significantly high level of willingness among breeders to explore other forms of traditional herbal medication ($p < 0.001$, 99.79%). The surveyed breeders expressed a marked interest in forms, such as tablets (78.96%) and suspensions (76.04%). Knowledge of these forms was more practiced ($p < 0.001$) in human medicine (100%) than in veterinary medicine (13.33%). The most important acceptance criteria ($p < 0.001$) were the effectiveness of the medication (94.13%), product availability (82.39%), and affordability (83.86%, Table 6).

Table 3. Effectiveness of traditional herbal medicines according to goat breeders from February to April 2023 in Benin

	Group 1			Group 2			Group 3			Z-test
	N	(%)	CI	N	(%)	CI	N	(%)	CI	
Effective	159	67.37ab	5.98	138	75.00a	6.26	33	55.00b	12.59	*
Ineffective	0	0.00a	0.00	3	1.63a	1.83	4	6.67b	6.31	***
Slightly effective	77	32.63ab	5.98	43	23.37b	6.11	23	38.33a	12.30	*

Group 1: Cluster 1, Group 2: Cluster 2, Group 3: Cluster 3, CI: Confidence interval, N: Number, *: $p < 0.05$, ***: $p < 0.001$, Frequencies on the same line, followed by the same letters, are not significantly different at the 5% threshold.

Table 4. Difficulties related to the use of traditional herbal medicines by goat breeders surveyed from February to April 2023 in Benin

	Group 1			Group 2			Group 3			Z-test
	N	(%)	CI	N	(%)	CI	N	(%)	CI	
Non-availability of certain plants throughout the year	63	26.69a	5.64	55	29.89a	6.61	28	46.67b	12.62	*
Conservation issues	88	37.29a	6.17	119	64.67b	6.91	59	98.33c	3.24	***
Uncertain dosages	40	16.95	4.79	27	14.67	5.11	9	15	9.04	NS
Scarcity or disappearance of certain plants	44	18.64	4.97	29	15.76	5.26	10	16.67	9.43	NS
Traveling long distances	23	9.75	3.78	17	9.24	4.18	6	10	7.59	NS

Group 1: Cluster 1, Group 2: Cluster 2, Group 3: Cluster 3, CI: Confidence interval, N: Number, NS: Not significant ($p > 0.05$), ***: $p < 0.001$, Frequencies on the same line, followed by the same letters, are not significantly different at the 5% threshold.

Table 5. Motivations of goat breeders surveyed from February to April 2023 for the use of medicinal plants in Benin

	Groupe 1			Groupe 2			Groupe 3			Z-test
	N	(%)	CI	N	(%)	CI	N	(%)	CI	
Expensiveness of conventional medicines	98	41.53a	6.29	146	79.35b	5.85	57	95c	5.51	***
Unavailability of conventional medicines	25	10.59a	3.93	52	28.26b	6.51	45	75c	10.96	***
Ineffectiveness of certain modern treatments	1	0.42a	0.83	20	10.87b	4.50	44	73.33c	11.19	***
Recognized efficacy of traditional remedies	160	67.8	5.96	140	76.09	6.16	38	63.33	12.19	NS
Valuing traditional pharmacopoeia	100	42.37a	6.30	43	23.37b	6.11	13	21.67b	10.42	***
Familiarity with the plant since childhood	134	56.78a	6.32	40	21.74b	5.96	5	8.33c	6.99	***
Less expensive	154	65.25a	6.08	147	79.89a	5.79	26	43.33b	12.54	***
Easy accessibility	119	50.42a	6.38	121	65.76a	6.86	17	28.33b	11.40	***

Group 1: Cluster 1, Group 2: Cluster 2, Group 3: Cluster 3, CI: Confidence interval, N: Number, NS: Not significant ($p > 0.05$), ***: $p < 0.001$, Frequencies on the same line, followed by the same letters, are not significantly different at the 5% threshold.

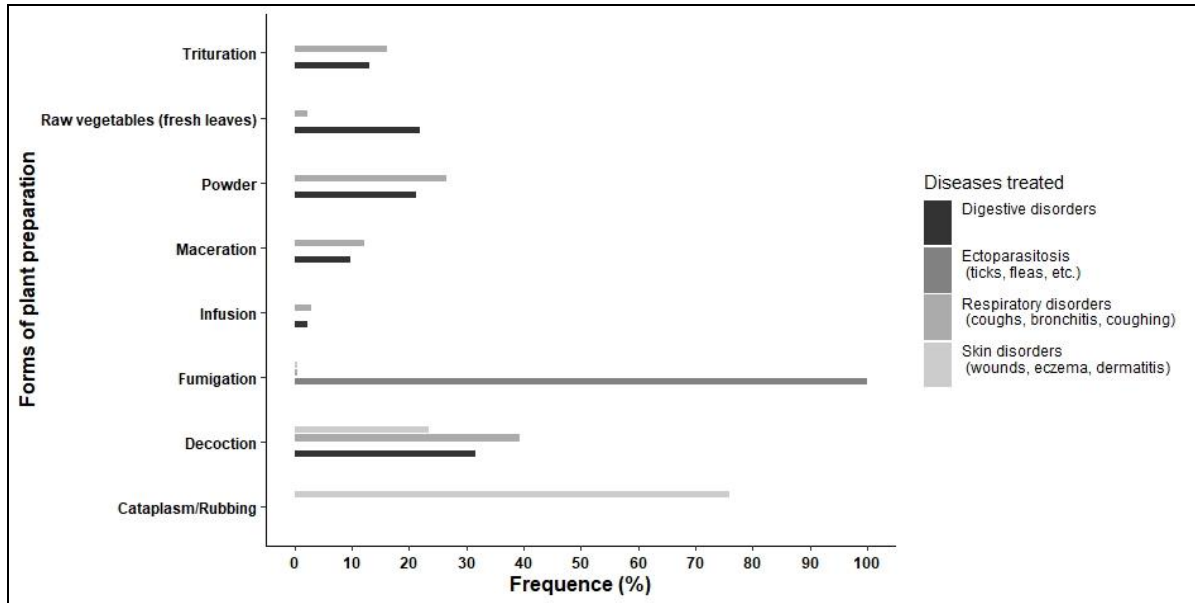


Figure 3. Forms of herbal medication and conditions treated by goat breeders surveyed from February to April 2023 in Benin

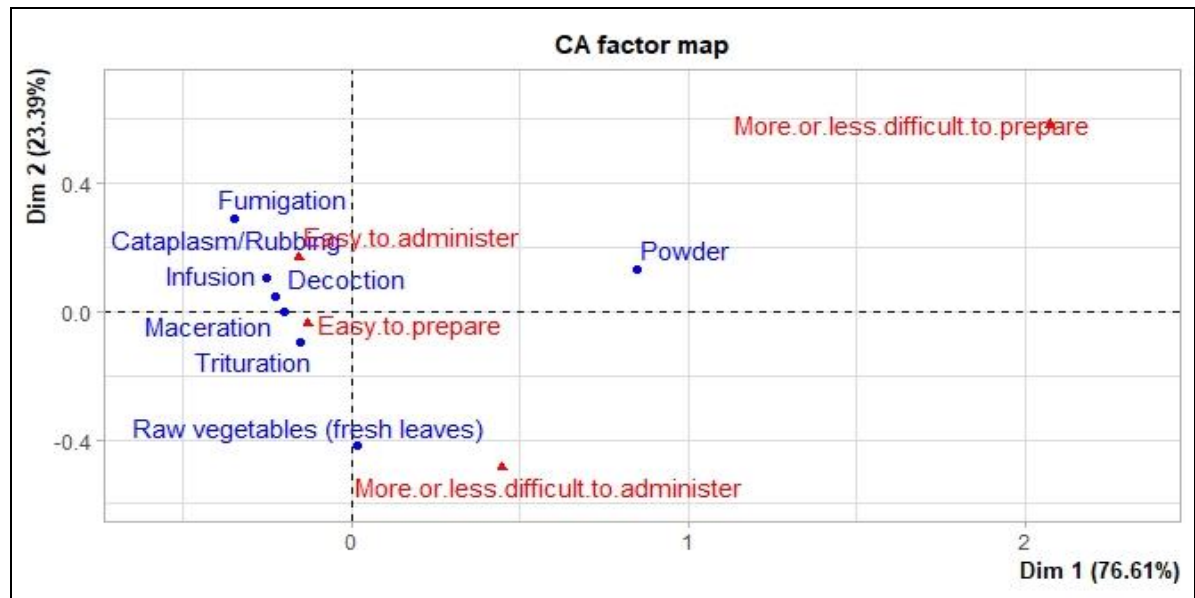


Figure 4. Ease of preparation and administration of herbal medicinal forms by goat breeders surveyed from February to April 2023 in Benin, Dim 1: Dimension 1; Dim 2: Dimension 2

Table 6. Perspectives of goat breeders surveyed from February to April 2023 for improving traditional herbal medication in Benin

Variables	Modalities	N	(%)	IC	Z-test
Willingness to use other forms	No	1	0.21a	0.41	***
	Yes	479	99.79b	0.41	
Desired forms	Suspension	365	76.04a	3.82	***
	Packet (powder)	150	31.25b	4.15	
	Tablet	379	78.96a	3.65	
	Capsule	92	19.17c	3.52	
	Injectable	28	5.83c	2.10	
Knowledge of these forms in	Veterinary medicine	64	13.33a	3.04	***
	Human medicine	480	100b	0.00	
	Affordable	400	83.86b	3.30	
	Effective	449	94.13d	2.11	
Acceptance criteria for improved traditional medicine	Ensures animal safety	198	41.51c	4.42	***
	Good packaging	178	37.32c	4.34	
	Product availability	393	82.39b	3.42	
	Ease of use	324	67.92a	4.19	

CI: Confidence interval, N: Number, ***: $p < 0.001$, Frequencies in the same column for the same variable, followed by different letters, are significantly different at the 5% level.

4. Discussion

This study has provided a better understanding of goat breeders' opinions regarding medicinal plant use. Three groups of breeders were identified based on their demographic characteristics and agricultural activities. The first group primarily consisted of agro-livestock breeders who mainly were married and uneducated men. Groups 1 and 2 were predominantly composed of farmers who were also primarily married men, but group 2 was more educated than those in group 1.

The observed male predominance in the use of medicinal plants for animal disease control in all the different groups can be explained by the fact that men are often heads of households, responsible for agricultural and livestock activities, while women are more involved in domestic tasks and child care. This division may have led to greater knowledge and involvement of men in using medicinal plants for animals. In addition, knowledge of medicinal plants is frequently passed down from generation to generation, mainly by male members, resulting in a persistent knowledge gap between the sexes¹⁵. This observation is consistent with the conclusion of a study that women belong to a social group with little knowledge of traditional veterinary medicine¹⁶. In addition, women are often excluded from public speaking on traditional matters, which can also impact the transmission of this knowledge. This social constraint may limit their access to information and knowledge about the use of medicinal plants for animal disease control in a study on ethnoveterinary knowledge of sheep and goat breeders in Benin¹⁶.

The high proportion of married individuals in livestock farming during this survey reflects their level of social responsibility and experience in animal management and husbandry¹⁷. Similar observations have been made among small ruminant breeders in Congo and Niger^{18,19}.

The predominance of agro-livestock breeders in Group 1 compared to Groups 2 and 3, where the majority of individuals were farmers, can be attributed to the strong presence of the Fulani people in Group 1. It should be noted that the Fulani people are traditionally livestock breeders, which explains this association. In Africa, the Fulani ethnic group has been recognized for their domestic ruminant livestock activities since ancient times. As a result, the name of this ethnic group has been given to several breeds of ruminants in Sahelian areas²⁰. The Fulani individuals were more or less sedentary, which allowed them to combine livestock rearing with agriculture.

The significant majority of illiterate breeders in all three groups is consistent with the observations made by a study in an ethnopharmacological survey of plants used to treat diseases in livestock in Benin⁴. The proportion of uneducated breeders was significantly higher in group 1, compared to groups 2 and 3. This can be justified by the fact that group 1 consists of breeders from the Alibori and Atacora departments, where the literacy rate is low¹². The vast majority of breeders have received no formal education in livestock rearing. This could be attributed to

the high illiteracy rate and the lack of professional support to enhance their livestock knowledge and skills.

Differences observed in the forms of medicinal plant use between groups highlight region- or ethnic-specific practices and the type of treated ailments. These variations can be linked to traditional knowledge from communities and locally available resources. Previous studies in Benin have demonstrated a great diversity in medicinal plant use, reflecting the richness of the Beninese traditional pharmacopoeia^{4,6}. These differences may relate to the most frequently encountered ailments in each group. Breeders adapt their practices according to the specific needs of their animals, utilizing the most appropriate forms of plant use to treat the encountered diseases. In this study, cataplasm/rubbing was used for skin conditions, while fumigation was preferred for ectoparasites. Most of the breeders surveyed treated digestive and respiratory ailments with decoctions, infusions, macerations, powders, triturations, and crude applications. These observations align with previous studies conducted in Benin, which identified various forms of medicinal plant use based on specific ailments encountered by sheep and goat breeders⁴. These findings underscore the importance of understanding the specific animal ailments within different groups and adapting the forms of medicinal plant use accordingly.

Breeders in group 1 used plants due to their easy accessibility, low cost, lifelong familiarity, and appreciation for traditional pharmacopeia, while those in groups 2 and 3 used them due to the high cost of conventional medicines and the effectiveness of traditional remedies. This difference can be justified by the fact that breeders in group 1 were located in northern Benin, in rural areas, which may explain their easy access to medicinal plants. In rural settings, natural resources, including medicinal plants, are often more readily accessible and an integral part of the local culture²¹. Therefore, breeders in group 1 would have lifelong familiarity and appreciation for traditional pharmacopeia, which motivates them to use plants for treating animal ailments. The motivations of breeders in groups 2 and 3 to use medicinal plants align with the findings of similar studies that have also identified the high cost of conventional medicines as one of the main reasons for using traditional remedies².

Breeders widely recognize the perceived efficacy of medicinal plants, reinforcing the importance of these traditional remedies in animal health. This perception of the effectiveness of medicinal plants agrees with numerous scientific findings that have demonstrated the efficacy of medicinal plants in treating various animal ailments, including gastrointestinal parasitoses⁷⁻⁹.

The difficulties breeders encounter in using traditional plant-based medicines in all three groups are primarily related to the preservation of medicines obtained through maceration, decoction, and trituration. According to these breeders, medicines prepared using these methods deteriorate and become moldy if not used within a few days of preparation. As a result, medicines are often

prepared and used on-site. Breeders in group 1 also highlighted the disappearance of certain plants and imprecise dosages as additional challenges. According to them, urbanization, deforestation, and the expansion of agricultural lands are responsible for the disappearance or scarcity of certain medicinal plants. Urbanization and the expansion of urban areas lead to a decline in natural resources due to the destruction of natural habitats. Similarly, deforestation, which is associated with expanding agricultural lands and economic activities, contributes to biodiversity loss. In addition to urbanization and deforestation mentioned by breeders in the current survey, the overexploitation of species and the scarcity of rainfall are also identified as threats to the survival of medicinal plants²². Breeders' observations on the scarcity or disappearance of certain medicinal plants are backed up by research carried out in Niger. This research has highlighted that 22 medicinal plant species are either already extinct or face the risk of extinction. These threats emanate from a variety of human activities, including the extraction of bark or roots, climatic variations, deforestation (for firewood, timber and construction), overgrazing, bush fires and the expansion of cultivated areas²³. Therefore, it is essential to implement conservation measures and raise awareness to preserve plant biodiversity and ensure a continuous supply of medicinal plants necessary for animal healthcare, thus maintaining traditional healing practices within breeder communities in Benin. The difficulties in preservation and imprecise dosages could lead to the ineffectiveness of traditional plant-based medicines, as reported by some breeders during the survey. It is vital to address these issues when promoting and using traditional plant-based medicines by developing appropriate conservation strategies and providing accurate information on dosages and modes of use.

According to the surveyed breeders, most forms of preparation of traditional plant-based medicines are generally easy to prepare and administer. However, some breeders in this study mentioned difficulties encountered when administering certain forms, particularly fresh leaves (raw form). According to their explanation, administering the leaves becomes complicated when an animal is weakened by illness, since the animal has to eat them itself.

The variations observed among the three groups of goat breeders, in terms of socio-cultural characteristics, motivations for using medicinal plants, forms of use, perceived effectiveness, and encountered difficulties, highlight the importance of considering regional and cultural specificities when developing policies and programs to encourage sustainable use of medicinal plants in the livestock sector.

The results of this study indicated a high willingness among breeders to explore new forms of traditional plant-based medicines. Among the forms that generated significant interest were suspensions and tablets. However, it is important to note that knowledge of these new forms of traditional herbal medicines is much more prevalent in traditional human medicine than in traditional veterinary

medicine. This can be attributed to the greater availability of improved traditional plant-based medicines on the market in the field of human medicine in Benin. This availability allows breeders to have better knowledge and experience in using these improved plant-based medicines. In contrast, in the field of veterinary medicine, the availability of improved traditional plant-based medicines is almost rare, which limits breeders' knowledge and use of these forms. Breeders also desired to benefit from these improved forms of traditional plant-based medicines in veterinary medicine. This would enable them to address the difficulties encountered in using traditional forms.

The surveyed breeders mentioned effectiveness as a primary criterion for the acceptability of desired forms and their availability and affordability. This concern is legitimate because the effectiveness of a vaccine or medication is not limited to its biological efficacy alone but also its availability, accessibility, and affordable cost²⁴. Therefore, it is crucial for improved traditional plant-based medicines to be affordable to avoid a situation where breeders turn to medicinal plants due to the high cost of conventional products.

Furthermore, a study reported that the unavailability of medicines and/or the absence of veterinary services in certain locations led some breeders to self-treat their animals using human pharmacy products. This situation highlights the urgent need for breeders to have access to medicines tailored to their needs, locally available, and qualified for animal health²⁵.

To promote the acceptability of improved traditional plant-based medicines, it is essential to ensure their effectiveness, availability, non-toxicity, and financial accessibility for breeders. A balanced approach that takes into account these criteria will be essential in meeting the needs of breeders while ensuring the health and well-being of their animals.

5. Conclusion

Research into how goat breeders in Benin perceive the use of medicinal plants has identified different groups of breeders classified according to their demographic characteristics and farming practices. The motivations for using medicinal plants varied, ranging from easy and affordable access to the perceived benefits of traditional remedies compared to conventional medications. Commonly used preparation forms include decoctions, powders, and crudity. Breeders expressed notable confidence in the effectiveness of medicinal plants for treating animal ailments. Nonetheless, certain challenges persist, notably concerning the preservation of medicinal forms and the precision of dosages. However, breeders showed a strong willingness to explore new forms of traditional plant-based medicines, highlighting effectiveness, availability, affordability, and non-toxicity as important criteria. These findings open up prospects for improving traditional medicines in Benin. Firstly, it is necessary to develop suspension and tablet forms, which have generated strong interest among breeders. These

forms could offer better convenience and ease of administration compared to traditional forms, such as decoction, maceration, or triturating.

Declarations

Competing interests

The authors declare that they have no conflict of interest.

Authors' contribution

Abiodoun Pascal Olounladé, Kadoéito Cyrille Boko, Mawulé Sylvie Hounzangbé-Adoté designed the survey forms and supervised data collection in the field. Kétomon Pierre Challaton collected with the help of Amos Gilles-Christ Akakpo and processed field data. With the help of Fréjus Tanguy Ablô Zinsou. Kétomon Pierre Challaton processed and statistically analyzed the data. He then interpreted the results and wrote the first draft of the manuscript. Coovi Guénolé Akouedegni and Goué Géorcelin Alowanou contributed to improving the scientific quality of the manuscript by proofreading the various versions. All authors have read and approved the final manuscript.

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Availability of data and materials

Data are included within the article.

Ethical considerations

Neither this manuscript nor any part of the research has been published in any form and is not under consideration for publication elsewhere. All authors are in agreement with the content of the manuscript and its submission to the journal.

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References

1. Tchetan E, Olounlade AP, Azando EVB, Quinet M, Marcotty T, Hounzangbe-Adoté SM, et al. La médecine ethnovétérinaire à la croisée de la recherche scientifique : Synthèse des connaissances et perspectives [Ethnoveterinary medicine at the crossroads of scientific research: Synthesis of knowledge and perspectives]. *Rev Elev Med Vet Pays Trop*. 2021a; 74(3): 167-175. DOI: [10.19182/remvt.36762](https://doi.org/10.19182/remvt.36762)
2. Houndje E, Ogni C, Noudeke N, Farougou S, Youssao A, and Kpodekon T. Recettes ethno-vétérinaire à base de plantes médicinales utilisées pour le traitement de la fièvre aphteuse au Bénin [Ethno-veterinary recipes based on medicinal plants used to treat foot-and-mouth disease in Benin]. *Int J Biol Chem Sci*. 2016; 10(5): 2090-2107. DOI: [10.4314/ijbcs.v10i5.13](https://doi.org/10.4314/ijbcs.v10i5.13)
3. Noudèkè ND, Dotché I, Ahounou GS, Karim IYA, and Farougou S. Inventory of medicinal plants used in the treatment of diseases that limit milk production of cow in Benin. *J Adv Vet Anim Res*. 2017; 4(1): 1-14. DOI: [10.5455/javar.2017.d183](https://doi.org/10.5455/javar.2017.d183)
4. Tchetan E, Olounlade AP, Houehanou TD, Azando EVB, Kaneho JA, Houinato MRB, et al. Ethnoveterinary knowledge of sheep and goat farmers in Benin (West Africa): Effect of socio-economic and environmental factors. *Heliyon*. 2021b; 7: e07656. DOI: [10.1016/j.heliyon.2021.e07656](https://doi.org/10.1016/j.heliyon.2021.e07656)
5. Degla LH, Olounlade PA, Lagnika L, Attindehou S, Amoussa AMO, Dansou CC, et al. Ethnobotanical survey on medicinal plants traditionally used for treatment of intestinal parasitosis of animals and humans in Northern Benin. *J Med Plants Res*. 2021; 5(10): 466-478. DOI: [10.5897/JMPR2021.7138](https://doi.org/10.5897/JMPR2021.7138)
6. Dansou CC, Olounlade PA, Konmy BSB, Songbé O, Arigbo KB, Aboh AB, et al. Ethno-veterinary survey and quantitative study of medicinal plants with anthelmintic potential used by sheep and goat breeders in the Cotton Zone of Central Benin (West Africa). *J*. 2021; 4(4): 544-563. DOI: [10.3390/j4040040](https://doi.org/10.3390/j4040040)
7. Pascal OA, Eloi AY, Bertrand AEV, Sylvie HAM, and Hervé H. Effet *in vivo* de *Newbouldia laevis* (Bignoniaceae) sur des strongles gastro-intestinaux des moutons [In vivo effect of *Newbouldia laevis* (Bignoniaceae) on sheep gastrointestinal strongyles]. *Eur Sci J*. 2017; 13(12): 335. DOI: [10.19044/esj.2017.v13n12p335](https://doi.org/10.19044/esj.2017.v13n12p335)
8. Azando EVB, Olounlade PA, Hounzangbe-Adoté MS, Tam Ha HA, Fabre N, and Valentin A. Contrôle des parasitoses gastro-intestinales ovines par l'huile essentielle de *Zanthoxylum zanthoxyloides* (Fagara zanthoxyloides) [Control of ovine gastrointestinal parasitosis with *Zanthoxylum zanthoxyloides* essential oil (Fagara zanthoxyloides)]. *Rev Med Vet*. 2017; 168(10-12): 205-212. Available at: https://ut3-toulouseinp.hal.science/hal-03148830/preview/AZANDO_2017.pdf
9. Alowanou GG, Azando EVB, Adenilé AD, Koudandé DO, Chrysostome CAM, and Hounzangbé-Adoté SM. Evaluation of the *in vivo* anthelmintic properties of *Mitragyna inermis* (Willd.) as a livestock dewormer against parasitic hematophagous worm *Haemonchus contortus* infections in different breeds of lambs. *Trop Anim Health Prod*. 2020; 52(1): 309-319. DOI: [10.1007/s11250-019-02014-w](https://doi.org/10.1007/s11250-019-02014-w)
10. Stathers TE, Chigariro J, Mudiwa M, Mvumi BM, and Golob P. Small-scale farmer perceptions of diatomaceous earth products as potential stored grain protectants in Zimbabwe. *Crop Prot*. 2002; 21(10): 1049-1060. DOI: [10.1016/S0261-2194\(02\)00089-3](https://doi.org/10.1016/S0261-2194(02)00089-3)
11. Oladele O, and Fawole O. Farmer's perception of the relevance of agriculture technologies in South-Western Nigeria. *J Hum Ecol*. 2007; 21(3): 191-194. DOI: [10.1080/09709274.2007.11905971](https://doi.org/10.1080/09709274.2007.11905971)
12. Institut national de la statistique et de l'analyse de l'économie. Principaux indicateurs sociodémographiques et économiques [Main socio-demographic and economic indicators] (RGPH-4, 2013). 2016; INSAE Benin. p. 27. Available at: https://instad.bj/images/docs/insae-statistiques/enquetes-recensements/RGPH/1.RGPH_4/Indicateurs-et-Projections/Principaux%20Indicateurs%20projections%20Preface%20RGPH4.pdf
13. Lê S, Josse J, and Husson F. FactoMineR: A package for multivariate analysis. *J Stat Softw*. 2008; 25(1): 1-18. DOI: [10.18637/jss.v025.i01](https://doi.org/10.18637/jss.v025.i01)
14. R project. The R project for statistical computing. 2021. Available at: <https://www.R-project.org/>
15. Ouattara KE, Doga D, Orsot BAMB, and Zlrihi GN. Plantes médicinales utilisées dans le traitement des maladies microbiennes dans la région du Hambol, nord de la Côte d'Ivoire [Medicinal plants used to treat microbial diseases in the Hambol region, northern Côte d'Ivoire]. *J Anim Plant Sci*. 2021; 47(1): 8412-8425. Available at: <https://m.elewa.org/Journals/wp-content/uploads/2021/01/6.Ouattara.pdf>
16. Hounzangbé-Adoté SM. L'élevage face à la pharmacopée en médecine vétérinaire au sud du Bénin. [Livestock farming and veterinary pharmacopoeia in southern Benin]. *Bull rech agron Bénin*. 2001; 33: 1-9. Available at: http://www.slire.net/download/1204/hounzangbe-adote_bra_033_2001.pdf

17. Yaye Abdou HY, Dayo GK, Issa M, Mani M, Idi I, and Marichatou H. Etude des pratiques d'élevage des moutons Peulh du Niger: Le Peulh blanc et le Peulh bicolore [Study of the breeding practices of the Peulh sheep of Niger: The white Peulh and the bicolored Peulh]. *Int J Biol Chem Sci*. 2019; 13(1): 83-98. DOI: [10.4314/ijbcs.v13i1.8](https://doi.org/10.4314/ijbcs.v13i1.8)
18. Wasso D, Akilimali J, Patrick B, and Bajope J. Élevage caprin: Situation actuelle, défis et impact socioéconomique sur la population du territoire de Walungu, République Démocratique du Congo [Goat breeding: Current situation, challenges and socio-economic impact on the population of Walungu territory, Democratic Republic of Congo]. *J Appl Biosci*. 2018; 129: 13050-13060. DOI: [10.4314/jab.v129i1.8](https://doi.org/10.4314/jab.v129i1.8)
19. Gadjimi AKM, Mamman M, Dayo GK, Abdou FS, Lawali S, and Hamani M. Aspects socioculturels et pratiques d'élevage des chèvres Rousse et Noire de Maradi au Niger [Sociocultural aspects and breeding practices of the Rousse and Noire goats of Maradi in Niger]. *J Agric Vet Sci*. 2020; 3(1): 23-37. DOI: [10.9790/2380-1301042337](https://doi.org/10.9790/2380-1301042337)
20. Lebroy M. Les soins au bétail chez les Peuls: Une tradition ancestrale [Care of the livestock, an ancestral tradition among the Fulanis]. *Bull soc Fr Hist méd sci Vét*. 2003; 2(2): 77-83. Available at: <http://www.ethnopharmacologia.org/prelude2020/pdf/biblio-vl-17-lobry.pdf>
21. Nicolas JP, Chikh K, Lebourier N, and Meunier Q. Savoirs traditionnels et santé communautaires: La stratégie alternative de Jardins du Monde [Traditional knowledge and community health: Jardins du Monde's alternative strategy]. *Jardins du Monde*. 2004; p. 70-75. Available at: <http://www.jardinsdumonde.org/wp-content/uploads/2016/03/Savoirs-traditionnels-et-sant%C3%A9-communautaires-strat%C3%A9gie-alternative-de-Jardins-du-monde-Chikh-Lebourier-Meunier-Nicolas.pdf>
22. Latoundji AF, Koko KIED, Djego SD, and Djego JG. Diversité et phytochimie des plantes médicinales utilisées dans le traitement traditionnel des maladies mentales aux nord de la République du Bénin [Diversity and phytochemistry of medicinal plants used in the traditional treatment of mental illness in the north of the Republic of Benin]. *Afr Sci*. 2019; 15(2): 44-56. Available at: <http://www.afriquescience.net/AS/15/5.pdf>
23. Mounkaila S, Soukaradji B, Morou B, Karim S, Issoufou HBA, Mahamane A, et al. Inventaire e gestion des plantes médicinales dans quatre localités du Niger [Inventory and management of medicinal plants in four localities in Niger]. *Eur Sci J*. 2017; 13(24): 498. DOI: [10.19044/esj.2017.v13n24p498](https://doi.org/10.19044/esj.2017.v13n24p498)
24. Zinsstag J, Schelling E, Waltner-Toews D, and Tanner M. From one medicine to one health and systemic approaches to health and well-being. *Prev Vet Med*. 2011; 101(3-4): 148-156. DOI: [10.1016/j.prevetmed.2010.07.003](https://doi.org/10.1016/j.prevetmed.2010.07.003)
25. Challaton KP, Boko KC, Akouedegni CG, Alowanou GG, Houndonougbo PV, and Hounzangbé-Adoté MS. Traditional goat rearing in Benin: Health practices and constraints. *Rev Elev Med Vet Pays Trop*. 2022; 75(1): 9-17. DOI: [10.19182/remvt.36893](https://doi.org/10.19182/remvt.36893)