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Use and utility redundancy of medicinal plants in ethnoveterinary medicine by local populations of the Brazilian Caatinga

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Abstract

Background The predominance of agropastoral activities in the Brazilian semiarid region is an important factor for human populations to continue using medicinal plants in ethnoveterinary medicine. Thus, we sought to document the Caatinga plants known for treating diseases in ethnoveterinary medicine and to evaluate the useful redundancy of diseases indicated by local populations in the Cariris Velhos region, state of Paraíba, in the Brazilian semiarid region.

Methods Questionnaires with semi-structured forms were applied in rural communities in the Brazilian Caatinga region. A total of 120 people were interviewed using the snowball technique.

Results Fabaceae, Euphorbiaceae and Rubiaceae were the families that obtained the highest number of citations. *Heliotropium indicum* was the species most cited by the local population. The stem bark and the leaves were the most cited parts used of the plants. Using the bark juice was the most prominent method in preparing the medicinal remedies. The disease which presented the greatest degree of utility redundancy was inflammation and the one with the least redundancy was fracture.

Conclusion A study on the use of medicinal plants by ethnoveterinary medicine in a region with a high incidence of agricultural and pastoral activities helps to preserve living knowledge.

Keywords Semiarid region, Veterinary, Domestic animals

Background

The interaction of human populations with biodiversity generated a series of events which enabled adaptation in different environments. In addition to personal needs, human populations developed skills and practices related to raising domestic animals, as well as animal care [1]. Local populations in the inland regions of Northeastern Brazil (where the Caatinga biome, a Seasonally Dry Tropical Forest is located) practice various livestock activities through raising domestic animals, such as cattle, goats, sheep and horses [2] since the colonial period (sixteenth century) [3]. The interaction between human groups, domestic animals and the environment at a time

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when it was difficult to obtain drugs and veterinary care may have led local populations to resort to using medicinal plants to treat their animals. This idea is supported by the fact that the preparation of ethnoveterinary remedies is a practice which has been perpetuated for centuries around the world [1].

The use of plants in veterinary treatment highlights both the potential of Caatinga species and the diversity of diseases that animals can face. Drawing an analogy with the resources of traditional human medicine, there are several medicinal plants in the Caatinga that can be useful in treating the same disease [4]. In addition, the frequency of a disease influences the learning and knowledge of more species for a single treatment [5]. Both ideas indicate that there is a utilitarian redundancy in using plants to treat diseases [6]. In other words, there are factors that influence people to know and/or use a greater or lesser number of medicinal plants in treating a disease. In this reasoning, knowing that the use of plants for veterinary treatment is an important practice by local populations, diseases have a different number of plants and this may be related to the frequency of the incidence of local diseases.

Among the diseases that affect domestic animals, inflammation caused by external skin injuries is frequently reported by local populations of the Caatinga [2, 7, 8], where plants with anti-inflammatory potential are used to accelerate the healing process [8]. These plants are known and used by the populations because they are effective in treating the disease, and various parts of the plant, such as the roots, leaves and bark, can be used to obtain natural medicinal remedies, and consequently improve the well-being of the animals [9].

The use of medicinal plants in ethnoveterinary medicine is an important activity in developing regions. In the state of Paraíba alone (in Northeastern Brazil), a total of 1,412,480 cattle, 826,43 goats and 812,227 sheep were counted in 2023 (IBGE, 2023). These numbers justify how profitable these activities are for these local populations, both for the source of protein and for accumulating wealth (local savings). However, conventional medicines are not always accessible, which leads animal owners to use traditional practices in animal care and welfare. Seeking alternatives in situations that compromise animal health shows how important the cultural issue linked to ancestral knowledge is.

In view of the above, the present study was carried out with the objectives to: (i) document Caatinga plants known for treating diseases in ethnoveterinary medicine; and (ii) evaluate the utility redundancy of veterinary diseases that affects domestic animals indicated by local populations of a region of the state of Paraíba, in the Brazilian semiarid region. Our hypothesis is that the diseases identified by local populations exhibit varying levels of utilitarian redundancy, with inflammation being expected to have a higher utilitarian redundancy value.

Methods

Study area and local populations

The study was conducted in the Cariri Velho region, in the state of Paraíba, a semiarid region of Brazil. Five areas located in the Cariri Velho region were selected to carry out the study: the municipality of Barra de Santana (communities of Altos dos Cardeiros, Malhadinha and Retiro); the municipality of São José dos Cordeiros (communities of Malícia, Riacho Fundo, Perico, Recanto, Guarita, Viveiro and João Ferreiro); the municipality of São João do Cariri (communities of Curral de Meio, Poço das Pedras and Sacramento); the municipality of Cabaceiras (communities of Serra do Monte and Caiçara); and the municipality of Monteiro (communities of Olho d'água and Catolé) (Fig. 1).

The state of Paraíba is located on the political geographic map of the Brazilian semiarid region. It is composed of a complex of vegetation that encompasses diverse environments, physiognomy and flora, locally known as Caatinga [10]. The Caatinga covers 863,752 km^2, corresponding to approximately 11% of the Brazilian territory. The region has irregular rainfall, high evapotranspiration rates [11] and high temperatures [12]. The Cariri Velho region has the lowest average annual rainfall in the Brazilian semiarid region, with a regional climate of Bsh (hot semiarid) characterized by high temperatures, annual averages of around 26 °C, low annual temperature ranges and scarce rainfall, which is highly concentrated in time and irregular [13]. The Cariri Velho region has a total of 29 municipalities.

From a cultural point of view, the local population is descended from indigenous people, *quilombolas* and European settlers as a result of the "European usurpation" process [14] that occurred during the sixteenth and seventeenth centuries (Catalog of manuscripts of the Captaincy of Paraíba, 2015). The arrival of settlers in the Caatinga was accompanied by cattle insertion which contributed to develop livestock activity in extensive or semi-extensive systems to the present day [15]. The literature has used the term "*Caatingueiros*" to designate the people who live in the Caatinga biome [16].

The local communities in the Cariri Velho region are primarily composed of farmers engaged in economic activities related to agriculture and livestock farming. It is common to cultivate legumes and vegetables during the rainy season, while the primary occupation in the dry season shifts to raising livestock such as cattle, goats, sheep and pigs. These animals are managed both freely in the Caatinga and in confined areas near homes. Local

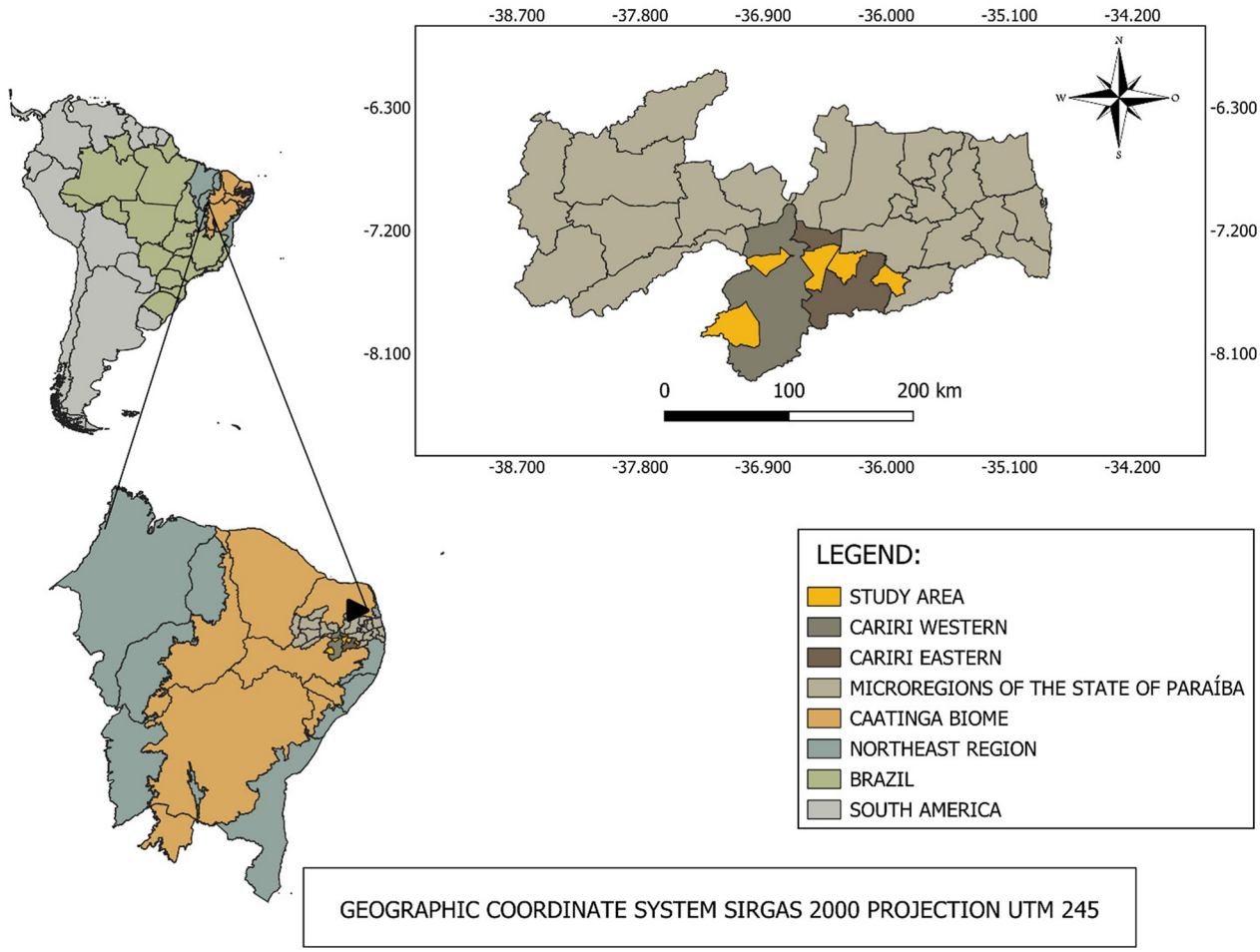

Fig. 1 Location map highlighting the Cariri region in the interior of Paraíba. Marked triangles highlight the communities studied. Purple triangle: São João do Cariri; blue triangle: Cabaceiras; orange triangle: Barra de Santana; green triangle: São José dos Cordeiros; yellow triangle: Monteiro

farmers play a crucial role in the healthcare of domestic animals and are primarily responsible for administering medicines to treat illnesses. However, depending on financial conditions and the severity or urgency of the illnesses, many choose to take their animals to veterinary clinics or seek specialized advice.

In addition to the farming activities that sustain their family income, the families rely on support from the federal government through programs such as the *Bolsa Família*, which provides income transfers, and *Seguro Safra*, which offers subsistence assistance to family farmers facing crop losses due to water shortages. Farmers also receive support from external government initiatives aimed at strengthening family farming. EMATER (the Technical and Rural Assistance Company) provides specialized technical assistance through professionals such as veterinarians, agronomists, zootechnicians and social workers with the goal of promoting sustainable rural development. In addition, the National Rural Learning Service (SENAR) plays a crucial role in strengthening rural activities. The region covered by this study benefits from the efforts of these two key organizations.

Survey of local ecological knowledge (LEK)

We used the snowball technique to select the research participants, which consists of participants indicating other people with similar skills to participate in the study. Thus, local experts (considered farmers) who represent a sample of the local population were selected at this stage. Data were collected between 2018 and 2020 (on average, twice a week). The interviews were conducted in Portuguese. After selecting the local experts, we conducted interviews with semi-structured forms to obtain the local ecological knowledge of the participants. The forms considered questions related to veterinary use, highlighting (i) which diseases the animals are affected by; (ii) which plants people know to treat diseases in domestic animals; (iii) which parts of the plant are used

to treat diseases in domestic animals; and (iv) how the remedies are prepared. All data collected from the semi-structured interviews were organized in the veterinary category according to the ethnobotanical literature [17]. The diseases mentioned by the local experts were organized according to [18].

We obtained a total of 120 interviewees, 77 men and 43 women, both aged between 24 and 88 years. The study area where the Olho d'água and Catolé communities are located has a smaller number of participants due to the Covid-19 pandemic, which made it impossible to collect data. More specifically, 32 people in the rural communities in the municipality of Cabaceiras (Serra do Monte and Caiçara) participated (21 men and 11 women); 30 (15 men and 15 women) in São João do Cariri (Curral do Meio, Poço das Pedras and Sacramento); 24 (19 men and 5 women) in Barra de Santana (Altos dos Cardeiros, Malhadinha and Retiro); 23 (15 men and 8 women) in São José dos Cordeiros (Malícia, Riacho Fundo, Perico, Recanto, Guarita, Viveiro and João Ferreiro); and 11 (7 men and 4 women) in Monteiro (Olho d'água and Catolé).

Ethical and legal aspects

This study was approved by the Research Ethics Committee (Plataforma Brasil), and authorization was granted under opinion No. 30657119.3.0000.5187, as recommended by Resolution No. 466/12/CNS/MS. Before the interviews, each informant was explained about the study and then asked to sign the Informed Consent Form required by the National Health Council through the Research Ethics Committee (CEP/HULW No. 297/11).

The plants were collected, identified with the help of experts and then classified according to the APG IV (Angiosperm Phylogeny Group) classification system and herborized in the Manuel de Arruda Câmara Herbarium of the State University of Paraíba (UEPB).

Data analysis

We used the utility redundancy model to identify the utility redundancy of the diseases cited by local experts through the index:

$$\text{Uredit} = \text{NSp} + \text{CR}$$

In which: NSp represents the total number of species cited for the indication and CR is the contribution of the disease to the generation of redundancy; CR was calculated by:

$$\frac{\sum \text{Si}}{\text{N}}$$

In which: Si represents the number of people who mentioned the disease, i the treatment of the veterinary indication and N represents the total number of people interviewed [19].

The diseases mentioned by the interviewees were organized according to Bharati and Sharma (2012) [9], with specific groups of diseases, each one being named according to its characteristics.

Results

Characterization of the cited plant species

We recorded 52 plant species belonging to 49 genera and 28 botanical families. We recorded a total of 374 citations. The plants were cited by local experts for the treatment of 20 veterinary diseases. The Fabaceae (nine species), Euphorbiaceae (nine species) and Rubiaceae (three species) botanical families stood out in terms of the number of species, while the other families had only two or one species cited (Table 1). The most cited species were *Heliotropium indicum* L, (38 citations), *Guapira hirsuta* (Choisy) Lundell (32 citations) and *Myracrodruon urundeuva* M. Allemão and *Sideroxylon obtusifolium* (Roem. & Schult.) T.D. Penn, (27 citations each).

Local experts highlighted the stem bark and the leaves among the useful parts of the plants mentioned for preparing medicinal remedies (Table 1). Medicinal remedies for each disease are prepared in different ways. In addition, we identified that several plant species were mentioned for treatment for each disease. Soaking the bark was indicated as the main method for preparing medicinal remedies (26 indications), mainly for treating inflammatory diseases and genital diseases. The bark juice (Fig. 2) can be administered orally in the form of a bottle (juice inside a bottle) containing the juice, or externally by washing the wound, improving healing. Another method mentioned was inserting or mixing scrapings of the bark or leaves of the plants with the animal's food, because according to the interviewees, ingestion helps to combat inflammation or worms. Likewise, it was also mentioned that the area in the case of a fracture/breakage of any animal limb can be bandaged with *Tocoyena formosa* leaf, which helps in restoring the fractured/broken bone.

Utility redundancy for Ethnoveterinary medicine

We sought to standardize the names of the illnesses mentioned by people. Thus, we named: "Uterine lavage" and "postpartum" as genital illnesses, for which 26 species of plants were mentioned for treatment; illnesses mentioned as "bloating" (indigestion) and "diarrhea" as digestive illnesses, with 17 species of plants used to treat them; illnesses mentioned as "*má triste*" (parasitic sadness complex), "bugs" and "worms" as parasitic

Table 1 Plant species cited by local experts from rural communities in the Brazilian semiarid region, followed by botany family, the scientific name of the species, vernacular name, part used:—B: Bark, WP: Whole plant, L: Leaf, R: Root, Fr: Fruit (dehiscent fruit), L: Latex, CL: Cladode, Br: Branch, S: Seed, Sh: Shoots, Fl: Flower. Therapeutic indication and herbarium collection number: NC (not collected) and ACAM (Herbarium Manuel of Arruda Câmara)

Botany family	Species/Vernacular name	Part used	Traditional use	Herbarium/Voucher
Amaryllidaceae	*Allium sativum* L (Alho)	PT	Parasitic illnesses	NC
Amaranthaceae	*Amaranthus spinosus* L. (Mastruz)	PT e FR	Parasitic illnesses; limb fracture; general inflammation	NC
Anacardiaceae	*Myracrodruon urundeuva* M. Allemão (Aroeira)	C	General inflammation; loss of appetite; injury; myiasis; rumen meteorism; diarrhea	ACAM 1991
Anacardiaceae	*Anacardium occidentale* L. (Cajueiro)	C	General inflammation	NC
Apocynaceae	*Aspidosperma pyrifolium* Mart (Pereiro)	C	Loss of appetite	ACAM 1995
Aristolochiaceae	*Aristolochia melastoma* Silva Manso ex Duch (Capitãozinho)	R	General inflammation	NC
Asparagaceae	*Aloe vera (*L.) Burm.f. (Babosa)	FR e PT	Loss of appetite; parasitic illnesses; secretions; infectious coryza; fighting lice	NC
Asteraceae	*Acanthospermum hispidum* DC (Carrapicho-de-cigano)	PT	Inflammation of the mammary glands; rumen meteorism	NC
Asteraceae	*Egletes viscosa (L.) Less. (*Macela)	PA	Diarrhea	NC
Bignoniaceae	*Handroanthus albus* (Cham.) Mattos (Pau-d'arco-amarelo)	C	General inflammation	NC
Bignoniaceae	*Tabebuia tiruculli* L. (Craibeira)	FL	Parasitic illnesses	NC
Boraginaceae	*Heliotropium indicum* L (Fedegoso)	C, PT e FR	Genital illnesses; general inflammation; rumen meteorism	ACAM 2027
Bromeliacea	*Neoglasiovia variegata* (Arruda) Mez (Caroá)		–	NC
Burseraceae	*Commiphora leptophloeos* (Mart.) J.B.Gillet (Imburana- de-cambão)	C	Rumen meteorism; cough	NC
Capparaceae	*Cynophalla flexuosa* (L.) J. Presl (Feijão-bravo)	C e V	Inflammation of the gastric mucosa constipation; fever; anger	ACAM 2014
Cactaceae	*Melocactus zehntneri* (Britton & Rose) Luetzelb (Coroa-de- frade)	PT	Parasitic illnesses	NC
Cactaceae	*Opuntia ficus-indica* (L.) Mill. (Palma)	CL	General inflammation	NC
Celastraceae	*Maytenus rigida* Mart (Bom- nome)	C	Genital illnesses	NC
Convolvulaceae	*Operculina macrocarpa* (L.) Urb. (Bata-de-pulga)	C	Genital illnesses	NC
Cucurbitaceae	*Momordica charantia L.* (Melão-de-são-caetano)	PA	Swelling	NC
Euphorbiaceae	*Jatropha mollissima* (Pohl) Baill. (Pinhão-bravo)	L	General inflammation; snakebite; stop blood	ACAM 1984
Euphorbiaceae	*Croton blanchetianus* Baill (Marmeleiro)	C	Genital illnesses; diarrhea	NC
Euphorbiaceae	*Cnidoscolus quercifolius* Pohl (Favela)	C	Injury; general inflammation	ACAM 1996
Euphorbiaceae	*Sapium glandulosum* (L.) Morong (Burra-leiteira)	C	Genital illnesses	ACAM 2010
Euphorbiaceae	*Manihot glaziovii* Müll.Arg (Maniçoba)	F	Rumen meteorism	NC
Euphorbiaceae	*Euphorbia tiruculli* L. (Aveloz)	FR	General inflammation	NC
Euphorbiaceae	*Jatropha ribifolia* (Pohl) Baill (Pinhão-rasteiro)	C	Snakebite	NC
Fabaceae	*Cenostigma pyramidale* (Tul.) Gagnon & G.P. Lewis (Catingueira)	FR e C	Cough	ACAM 1988
Fabaceae	*Anadenanthera colubrina* (Vell.) Benth. (Angico)	C	Genital illnesses; General inflammation; infectious coryza	ACAM 1982
Fabaceae	*Amburana cearenses* (Alemão A.C.Sm) (Cumarú)	C e FR	Cough	ACAM 1981
Fabaceae	*Caesalpinia ferrea* Mart. ex Tul (Jucá)	V e FR	General inflammation; rumen meteorism; inflammation of the mammary glands	ACAM 1996
Fabaceae	*Mimosa tenuiflora* (Willd.) Poir (Jurema-preta)	C	Cicatrization	ACAM 1989
Fabaceae	*Mimosa ophthalmocentra* (Mart.) Benth (Jurema- vermelha)	C	Rumen meteorism	NC
Fabaceae	*Hymenaea courbaril* L. (Jatobá)	C	Cough	NC
Fabaceae	*Bauhinia cheilantha* (Bong.) Steud (Mororó)	C	General inflammation; loss of appetite; inflammation of the mammary glands; cough	ACAM 1986
Fabaceae	*Erythrina velutina* Willd. (Mulungu)	S	Rumen meteorism	NC

Table 1 (continued)

Botany family	Species/Vernacular name	Part used	Traditional use	Herbarium/Voucher
Isoaceae	*Aosa rupestres* (Gardner Weigend) (Urtiga-branca)	R	Injury	NC
Lamiaceae	*Melissa officinalis* L (Cidreira)	PA e FR	Rumen meteorism	NC
Malvaceae	*Pseudobombax marginatum* (A.St.-Hil., Juss. & Cambess.) A.Robyns; (Embiratã)	C	General inflammation	NC
Malvaceae	*Waltheria rotundifolia* Schrank (Malva-branca)	C	General inflammation; limb bang; injury	NC
Nyctaginaceae	*Guapira hirsuta* (Choisy) Lundell (João mole)	C	Parasitic illnesses; genital illnesses; fever	NC
Nyctaginaceae	*Boerhavia difusa* L. (Pega-pinto)	RM	Infectious coryza	NC
Olacaeae	*Ximenia americana* L. (Ameixa)	C	General inflammation; limb bang; injury	NC
Phyllanthaceae	*Phyllanthus niruri* L. (Quebra- pedra)	R	Genital illnesses	NC
Rubiaceae	*Amorimia septentrionalis W.R.Anderson* NC (Tinguim)	S	Anger	NC
Rubiaceae	*Coutarea hexandra* (Jacq.) K. Schum (Quina-quina)	C	Rumen meteorism; Parasitic illnesses	NC
Rubiaceae	*Tocoyeana formosa* (Cham. & Schltdl.) K.Schum (Genipapo)	FR e PA	Limb fracture; injury	NC
Rhamnaceae	*Ziziphus joazeiro* Mart. (Juazeiro)	C	Cough	ACAM 1933
Sapotaceae	*Sideroxylon obtusifolium* (Roem. & Schult.) T.D. Penn. (Quixabeira)	C	General inflammation; genital illnesses; injury	ACAM 1994
Solonaceae	*Solanum paniculatum* L. (Jurubeba)	PT	-	NC

Fig. 2 *Heliotropium indicum* recorded in rural communities in the Brazilian semiarid region. **A** leaves of the plant; **B** whole plant; **C** preparation by soaking the leaves to treat inflammation and postpartum uterine lavage in animals. Photos: Kamila M.Pedrosa

illnesses, with 22 species of plants for treatment; illnesses mentioned as "wound healing" as wounds, with 24 species of plants mentioned; illnesses mentioned as "rabies," "chicken fever" and "cough" were grouped as viral illnesses, which had 13 species mentioned for treatment; the diseases cited as "general inflammation" were included as Inflammation, and 33 species of plants cited for treatment were obtained, and we also named a Breakage group for the citations of "fractured/broken bone," which recorded seven species cited for treatment.

The diseases presented different utility redundancy values. We recorded the highest utility redundancy for the

disease inflammation (Uredit = 34.09) and the lowest utility redundancy for fracture (Uredit = 7.16). The remaining diseases included: genital illnesses (27.08), wounds (24.00), parasitic illnesses (22.95), digestive illnesses (17.52) and viral illnesses (13.19).

Discussion

Our study showed that people know a significant number of plants which are useful in ethnoveterinary medicine, specifically plants from the Fabaceae and Euphorbiaceae botanical families, which is also a fact identified in other studies [20, 21]. This representativeness may be related to the bioactive potential of the species that belong to these families, and also because they are the most abundant plant families in the Caatinga [2, 22].

The number of plants known to treat veterinary diseases may be linked to farmers' daily practices with domestic animals. Farmers in the study area use the diverse plants of the Caatinga as animal fodder [23] which provides them with daily contact with these species, fostering learning about their use in treating diseases. The interaction between plants and humans is so strong that farmers observe their animals adjusting their diet according to the predominance of plant species in each season [23]. This practice is particularly important, given that the health of domestic animals begins with proper nutrition [24], which in this case would be natural fodder from local biodiversity.

In the use and preparation of medicinal remedies, we show how the local experts indicated that they were more interested in the bark and stem of the species, which is interesting given that the highest bioactive concentration in Caatinga plants is found in the stem bark [20]. Furthermore, this result can be explained by the fact that the bark is always available for a longer period of time, and so local populations use the species throughout the year. This supports the hypothesis of climatic seasonality proposed by the researcher Ulysses Albuquerque [7], because although there are leaves and flowers with potential for use, this is restricted to the rainy season. On the other hand, the leaves were the most frequently used, and this may be related to the herbaceous habit of the *H. indicum* species. This species was the most frequently cited plant for treating postpartum uterine lavages, which consists of treating complications such as retained placenta and endometritis. The use of *H. indicum* prepared lavages helps to remove residues and fluids accumulated in the animal's uterus, promoting reproductive health of the female. Preparing medicinal remedies can be done with all parts of the plant since they have effective active ingredients [25]. In the study by Chandan Sarkar et al. (2021) [26] based on a systematic review of pharmacological and ethnomedicinal activities, it was shown that *H. indicum* contains important phytochemicals for treating various diseases [5].

We observed that using bark juice is one of the most reported preparation methods. This indication was also common in other studies [18]. The juice of plant parts is the most common method used to extract bioactives [27]. It is first necessary to soak the plant parts used in water for a few days to obtain the juice, and then offer or apply it directly to the animal [16]. This method was also described by the interviewees in our study, who place it in a bottle after the bark juice is ready, and then offer it to the animal or even use it to wash wounds, helping with healing. As we found in our results, it was found in the study of [28] that the medications are also offered to animals orally, and this treatment lasts for a few days until the animal shows improvement in their condition, demonstrating its effectiveness in treating diseases in a safe, effective and inexpensive way.

The connections between local knowledge of plants used to treat human ailments (ethnomedicine) can have significant implications for learning about and managing the health of domestic animals (ethnoveterinary). In the context of using zootherapy animals in ethnoveterinary medicine, it has already been identified that some traditional veterinary medicines used by local populations in the semiarid region of Paraíba, Brazil, are based on species that treat diseases similarly or even identical to those affecting humans [29]. In addition [29], they pointed out that the relationship between ethnomedicine and ethnoveterinary medicine is closely linked due to the fact that both groups are made up of mammals. The case of ethnoveterinary medicines are for non-human mammals, such as cattle, sheep and goats, while ethnomedicine focuses on humans [30] who often face similar health problems. For example, approximately 80% of the plants used in traditional veterinary medicine in the Mediterranean region of Greece are also used to treat similar conditions in humans [31].

Among the illnesses reported by the participants, we observed that genital inflammation and diseases were the illnesses with the greatest redundancy, which can be explained by the fact that they most affect the animals where the study was conducted. Although we did not question the incidence of diseases (the diseases which most affected the herd) during the study, domestic animals, such as cattle and goats, are generally extensively raised in Caatinga biome forests and can suffer accidents due to contact with thorny plants, which can cause inflammation. With regard to genital diseases, it is important to highlight that these animals generally give birth naturally, without immediate assistance, which contributes to the high incidence of these problems. Furthermore, people use plants that are considered efficient for

treatment as an alternative. At the same time, the greatest utility redundancy indicates that people cited a greater number of plants that can be used.

Alternatively, we identified that the disease with the least utility redundancy was fracture, as it presented a low number of cited plants. Fractures are difficult to manage when there is no veterinary assistance. The limbs are usually bandaged with medicinal plants, but there is a prevalence of infections that often cause death of the animal. In more serious situations, as seen by Hussain et al. (2021) [32], animals are euthanized because people cannot get treatment to help them [28].

Utilitarian redundancy generally contributes to understanding plant usage patterns through analyzing human adaptations. Species that contribute to utilitarian redundancy tend to indicate that there is taxonomic affiliation between them [33]. In addition, local populations see this affiliation through the similarities between species, since there is sharing of chemical characteristics between plants [10]. The theory highlights the strategies that our species uses during plant selection [4]. Several authors have shown that local ecological knowledge was constructed to be redundant, since it learned that several species are functionally used in treating the same disease [34]. Moreover, this is particularly important, because in the present study it was possible to identify that people know a range of opportunities to treat specific diseases that affect domestic animals.

Conclusion

Our results revealed a rich body of local ecological knowledge regarding plants used in the ethnoveterinary care of local herds. We observed that some species stood out for their versatility in treating multiple ethnoveterinary diseases, with remedies primarily prepared by soaking the bark. Inflammation showed the greatest utility redundancy, while fractures had the lowest utility redundancy. All of our inferences contribute to better understanding on the use of medicinal plants, specifically when indicated in ethnoveterinary medicine. In addition, our findings underscore the importance of integrating traditional knowledge with modern scientific approaches, which could open up new possibilities for developing alternative and sustainable veterinary therapies. Continued and expanded research in this field is essential to strengthen the knowledge base on the use of medicinal plants in ethnoveterinary medicine, not only preserving this traditional knowledge, but also fostering innovation in animal healthcare and herd management. This will help address the emerging needs of livestock farming while promoting biodiversity conservation.

Abbreviations

APG	Angiosperm phylogeny group
IBGE	Brazilian institute of geography and statistics
CNPq	Brazilian council for scientific and technological development
CEP/HULW	Research ethics committee
FAPESq	Fundação de Apoio à Pesquisa do Estado da Paraíba

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Author contributions

KMP, JRFG and SFL conceived the research idea. KMP and MBR did the data collection. JRFG and KMP analyzed and interpreted the data. KMP, JRFG and SFL revised and improved the manuscript. All the authors read, reviewed and approved the final version of the manuscript.

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Availability of data and materials

No datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the guidelines required by the National Health Council of Brazil through the Research Ethics Committee (resolution no. 466/12/CNS/MS; project approval protocol: 30657119.3.0000.5187).

Consent for publication

Not applicable in this section.

Competing interests

The authors declare no competing interests.

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References

1. Githiori JB, Höglund J, Waller PJ. Ethnoveterinary plant preparations as livestock dewormers: practices, popular beliefs, pitfalls and prospects for the future. Anim Health Res Rev. 2012;6(01):91–103. https://doi.org/10.1079/ahr2005099.
2. Souto WMS, Barboza RRD, Mourão JS, Alves RRN. Traditional knowledge of sertanejos about Zootherapeutic practices used in ethnoveterinary medicine of NE Brazil. Indian J Tradition Knowl. 2012;11(2):259–65.
3. Catálogo dos manuscritos da Capitania da Paraíba. Coleção: Fontes documentais Coloniais do Semiárido Brasileiro. 2015. In: Apolinário JR, Diniz MO, Bezerra HA. (Eds.). Campina Grande. Instituto do Semiárido (INSA). IBSN 978 8564265–08–0. Pp: 214.
4. Albuquerque UP, Oliveira RF. Is the use-impact on native caatinga species in Brazil reduced by the high species richness of medicinal plants? J Ethnopharmacol. 2007;113(1):156–70.
5. Santoro FR, Nascimento ALB, Soldati GT, Ferreira Júnior WS, Albuquerque UP. Evolutionary ethnobiology and cultural evolution: Opportunities for research and dialog. J Ethnobiol Ethnomed. 2018;14(1):2–14. https://doi.org/10.1186/s13002-017-0199-y.
6. Medeiros PM, Ferreira Júnior WS, Queiroz FS. Utilitarian redundancy in local medical systems—theoretical and methodological contributions.

J Ethnobiol Ethnomed. 2020;16(62):2–11. https://doi.org/10.1186/s13002-020-00416-x.
7. Albuquerque UP. Re-examining hypotheses concerning the use and knowledge of medicinal plants: A study in the Caatinga vegetation of NE Brazil. J Ethnobiol Ethnomed. 2006. https://doi.org/10.1186/1746-4269-2-30.
8. Amorin WR, Souza CP, Martins NG, Melo ES, Silva ICR, Corrêa PGN, Santos ARSS, Carvalho SMR, Pinheiro REE, Oliveira JMG. Estudo etnoveterinário de plantas medicinais utilizadas em animais da microrregião do Alto Médio Gurguéia—Piauí. Pubvet. 2018;12(10):1–5.
9. Bharati KA, Sharma BL. Plants used as Ethnoveterinary Medicines in Sikkim Himalayas. Ethnobot Res Appl. 2012;10:339–56.
10. Fernandes MF, Cardoso D, de Queiroz LP. An updated plant checklist of the Brazilian Caatinga seasonally dry forests and woodlands reveals high species richness and endemism. J Arid Environ. 2020;174:1–8. https://doi.org/10.1016/j.jaridenv.2019.104079.
11. Moreira JN, Lira MA, Ferreira MA, Santos MVF, Araújo GGL, Ferreira RLC, Silva GC. Caracterização da vegetação de Caatinga e da dieta de novilhos no Sertão de Pernambuco. Pesq agropec bras Brasília. 2006;41(11):1643–51.
12. Cardoso JM, Leal SI, Editors M. Caatinga. The Largest Tropical Dry Forest Region in South America. https://doi.org/10.1007/978-3-319-68339-3
13. Alvares CA, Stape JL, Sentelhas PC, De Moraes Gonçalves JL, Sparovek G. Köppen's climate classification map for Brazil. Meteorol Z. 2013;22(6):711–28.
14. Biomas e sistema costeiro-marinho do Brasil: compatível com a escala 1:250 000. IBGE; 164 p. (2019).
15. Holanda AC, Lima FTD, Silva BM, Dourado RG, Alves AR. Vegetation structure caatinga in remaining from different with historical disturbance in the region of Cajazeirinhas—PB. Revista Caatinga. 2015;28(4):142–50.
16. Agra MF, Baracho GS, Nurit K, Basílio IJLD, Coelho VPM. Medicinal and poisonous diversity of the flora of "Cariri Paraibano." Brazil J Ethnopharmacol. 2007;111(2):383–95.
17. Albuquerque UP, Cunha LVFC, Lucena RFP, Alves RRN. Methods and Techniques in Ethnobiology and Ethnoecology [Internet]. 2014. Available from: http://www.springer.com/series/8623
18. Souza and Silva, AA, Santos SS, Ferreira EC,Carvalho TKN, Lucena CM, Nunes GM, Madruga-Filho, VJP, Lucena RRP, Lucena RFP. Utilização de plantas na veterinária popular no semiárido da Paraíba, nordeste do Brasil. Flovet. 2018; 1(10),37–60.
19. Medeiros PM, Ferreira-Júnior WS, Queiroz FS. Utilitarian redundancy in local medical systems—theoretical and methodological contributions. J Ethnobiol Ethnomed. 2020. https://doi.org/10.1186/s13002-020-00416-x.
20. Júnior LRP, Andrade AP, Araújo KD, Barbosa AS, Barbosa FM. Espécies da caatinga como alternativa para o desenvolvimento de novos fitofármacos. Floresta e Ambiente. 2014;21(4):509–20.
21. Arévalo-Marín E, de Farias Lima JR, Palma AR, de Lucena RF, da Cruz DD. Traditional knowledge in a rural community in the semi-arid region of Brazil: age and gender patterns and their implications for plant conservation. Ethnobot Res Appl. 2015;7(14):331–44.
22. Aremu AO, Lawal IO. An analysis of the ethnoveterinary medicinal uses of the genus *Aloe* L. for animal diseases in Africa. South Afr J Botany. 2022;147:976–92. https://doi.org/10.1016/j.sajb.2022.02.022.
23. Cunha S, Ramos MB, Almeida HA, Maciel MGR, Souza SM, Pedrosa KM, Faria SL. Vegetation cover and seasonality as indicators for selection of forage resources by local agro-pastoralists in the Brazilian. Sci Rep. 2022;12(1):1–10.
24. Vogl CR, Vogl-Lukasser B, Walkenhorst M. Local knowledge held by farmers in Eastern Tyrol (Austria) about the use of plants to maintain and improve animal health and welfare. J Ethnobiol Ethnomed. 2016;12:1–7.
25. Dash GK, Abdullah MS. A review on *Heliotropium indicum l* (Boraginaceae). Int J Pharm Sci Res. 2013;4(4):1253–8.
26. Sarkar C, Mondal M, Khanom B, Hossain MM, Hossain MS, Sureda A, Islam MT, Martorell M, Kumar M, Sharifi-Rad J, Al-Harrasi A, Al-Rawahi A. *Heliotropium indicum* L.: from farm to a source of bioactive compounds with therapeutic activity. Eviden Based Complement Alternat Med. 2021;2021:1–21. https://doi.org/10.1155/2021/9965481.
27. Ul Hassan H, Murad W, Tariq A, Ahmad A. Ethnoveterinary study of medicinal plants in Malakand Valley, District Dir (Lower), Khyber Pakhtunkhwa. Pakistan Ir Vet J. 2014. https://doi.org/10.1186/2046-0481-67-6.
28. Pratama AM, Herawati O, Nabila AN, Belinda TA, Wijayanti AD. Ethnoveterinary study of medicinal plants used for cattle treatment in bojonegoro district, east java. Indonesia Biodiversitas. 2021;22(10):4236–45.
29. Souto WMS, Barboza RRD, Mourão JS, Alves RRN. Traditional knowledge of sertanejos about Zootherapeutic practices used in ethnoveterinary medicine of NE Brazil.2012; 11(2):259-265
30. Confessor MVA, Mendonça LET, Mourão JS, Alves RRN. Animals to heal animals: ethnoveterinary practices in semiarid region, Northeastern Brazil. J Ethnobiol Ethnomed. 2009;5(37):1–9.
31. Pieroni A, Giusti ME, De Pasquale C, Lenzarini C, Censorii E, Gonzáles-Tejero MR, Sánchez-Rojas CP, Ramiro-Gutiérrez JM, Skoula M, Johnson C, Sarpaki A. Circum-Mediterranean cultural heritage and medicinal plant uses in traditional animal healthcare: a field survey in eight selected areas within the RUBIA Project. J Ethnobiol Ethnomed. 2006;2:1–2.
32. Hussain A, Zafar M, Shinwari S, Shinwari ZK, Ahmad M, Sultana S, Yassen G. Ethnoveterinary uses of medicinal plants as herbal drugs for sustainable livestock in southern deserts of Sindh Pakistan. Pak J Bot. 2021;53(2):673–90.
33. Reinaldo R, Albuquerque UP, Medeiros P. Taxonomic affiliation influences the selection of medicinal plants among people from semi-arid and humid regions—a proposition for the evaluation of utilitarian equivalence in Northeast Brazil. PeerJ. 2020;8:e9664. https://doi.org/10.7717/peerj.9664.
34. Albuquerque UP, de Medeiros PM, Ferreira Júnior WS, da Silva TC, Silva RRV, Gonçalves-Souza T. Social-ecological theory of maximization: basic concepts and two initial models. Biol Theory. 2019;14(2):73–85.

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