



Ethnobotany and impact of extractive activity on *Sideroxylon obtusifolium* (Roem. & Schult.) TD Penn. in a semiarid area of northeastern Brazil

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Currently, the term most used when referring to natural products is sustainability, which associates information from traditional knowledge with the promotion of environmental conservation. The present study was carried out in the Tapera Community, a semiarid region of Paraíba, to record and analyze the uses, traditional knowledge and extraction pressure suffered by *Sideroxylon obtusifolium*, commonly known as jungleplum. Householders of 69.69% of the residences were interviewed to obtain the information about use and knowledge. The extraction pressure was evaluated through two techniques: evaluation of the local availability of the species (through the 24-h walk) and evaluation of bark extraction pressure (extraction measurements). The jungleplum is used by the residents mainly for medicinal purposes, the bark is the most cited part and infusion is the most common form of preparation. A total of 88 trees were recorded, with 19 having extraction marks. The young specimens are part of the bark extraction records; however, near the residences, the extractions were carried out primarily on adult trees. Predatory activities were significantly reduced compared to previous data, as a result of the partnership established (residents and Cariri EPA–Lajedo do Pai Mateus), increased incentives from the Federal Government, and increased inspections in the areas around the Conservation Unit.

Keywords: Bark, Extractivism, Jungleplum, Traditional knowledge

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Studies on medicinal plants have sought to understand how people manipulate the environment, providing pathways to achieve the smallest possible impact by trying to reproduce these techniques in other environments¹. Currently, the term most used when referring to natural products is sustainability, which associates information from traditional knowledge with the promotion of environmental conservation².

In the semiarid region of northeastern Brazil, several studies have identified plant resource-use pressure. The characteristic vegetation of this region is the caatinga (semiarid vegetation) and this biome, which has historically suffered both socially and economically over the years, has seen its biodiversity reduced by the production of charcoal and firewood to supply mainly industries and trade³. This biome has been indiscriminately exploited, often in an uncontrolled and unsustainable way, leading to environmental degradation, threatening biodiversity, and promoting large areas of desertification⁴.

An important use of the Caatinga's plant resources is its use through different preparations as a remedy and several studies have already demonstrated that bark is the main component of tree species used for medicinal purposes^{5,6,7,8,9}.

A study in Alagoinha, Pernambuco, a semiarid region in Northeast Brazil, reported a concern about the impact produced by the large-scale extraction of natural resources. In this region, plant resources are used mainly for the supply of trade in the production of traditional medicines, which threatens the local flora due to the lack of extraction techniques and cultivation methods that can help propagate exploited species¹. Inadequate management, especially of the stem bark, can lead to plant death through the removal of its transport system¹⁰.

Among the tree species in the caatinga with medicinal use, the jungleplum, in Portuguese called quixabeira (*Sideroxylon obtusifolium* (Roem. & Schult.) TD Penn.) is one of the most known and its use has been cited and recorded in several communities^{9,11,12,13,14}. The jungleplum is known

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for its anti-inflammatory, antidiabetic and healing properties^{15,16,17}. A 10-year study in the Paraíba semiarid region recorded an intense and uncontrolled extractive activity, where approximately 90 k of bark was removed monthly, prioritizing the extraction of young individuals, which the residents believe to have greater medicinal efficacy¹⁶. This type of activity has led to the local reduction of jungleplum specimens since poorly performed extractions can lead to plant stress or death^{18,19}.

Considering the importance and form of use of *S. obtusifolium* in the caatinga, the present study aimed to evaluate the uses and the knowledge that a population of the semiarid region has of the species to investigate the intensity and the impact of its extraction. More specifically, the objectives were a) to record the knowledge and uses of *S. obtusifolium*, b) to analyze the local distribution of the species and c) to evaluate the impact of the extraction of *S. obtusifolium* bark.

Methodology

Study Area

The Cabaceiras municipality has an area of 400.22 km² and is located in the Borborema mesoregion and

Eastern Cariri microregion (Fig. 1). The average temperature is 23.4°C and with little rainfall throughout the year (the annual rainfall is 300 mm³). It is bordered by 5 municipalities (São João do Cariri, São Domingos do Cariri, Barra de São Miguel, Boqueirão and Boa Vista). It has 5,035 inhabitants, where the rural population outnumbers the urban one²⁰. It is traditionally a pastoral region, where goat and sheep farming have predominated²¹. Despite the presence of semiarid vegetation throughout is whole area, it uses subsistence farming for corn, beans and cassava in drip irrigated areas or during rainy periods²².

The present study was carried out in the Tapera Community, accessed by a dirt road near PB-16, located in the vicinity of the Cariri – Lajedo do Pai Pai Mateus Environmental Protection Area (EPA), approximately 20 km from the city of Cabaceiras, Paraíba. The EPA is located in a private area, managed and maintained by its owners, who allow visits to the protection area but prohibit any harmful activities to the environment.

The Cariri EPA-Lajedo do Pai Mateus was created in 2004 and covers approximately 18,500 ha, encompassing the Boa Vista, Cabaceiras and São João

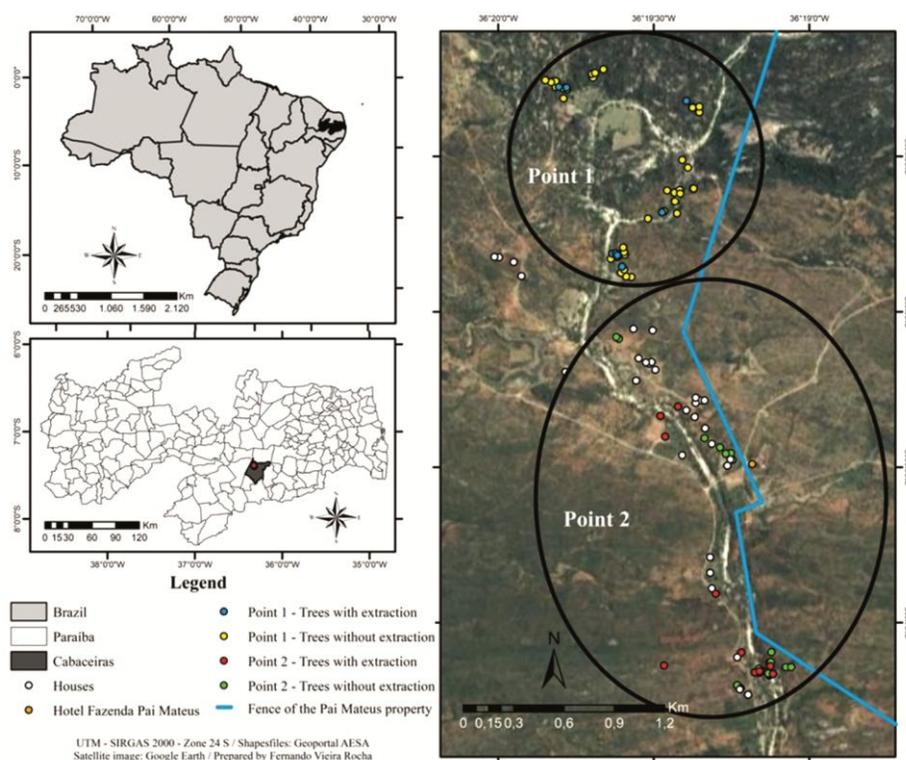


Fig. 1 A — Map showing the location of the Cabaceiras municipality. B- Distribution map of the species *Sideroxylon obtusifolium* (ROEM. & SCHULT.) TD PENN in the Tapera community, Cabaceiras, in a semiarid region of Paraíba, northeastern Brazil

do Cariri municipalities. The Cariri EPA does not have a management plan²³, one of the requirements for a conservation unit that must be met in up to 5 years after its creation, according to article 27 paragraph 3 of Law No. 9. 985/2000. It is not enough to just create the conservation unit; its supervision and management by public and environmental agencies is also necessary to ensure the conservation of natural resources. However, even without a management plan, the area is preserved, and any anthropogenic activity that affects the environment is prohibited²³.

The Fazenda Pai Mateus Hotel was built in 1997 in the Cariri EPA-Lajedo do Pai Mateus. The Brazilian movie "Auto da Compadecida"(1998) was partially recorded in Lajedo do Pai Mateus and added value to the region. After the approval of the Municipal Plan that created the sign "Roliúde Nordestina" (2007) (a sign placed at the entrance to the city, in a reference to Hollywood), the Lajedo do Pai Mateus become even more known and visited by tourists from Paraíba, Brazil and abroad, providing additional income to some residents who work as laundresses, chambermaids, cleaners, tour guides and interpreters. In addition, the place appeals to film production companies and numerous Brazilian cinematographic productions have been recorded in this area, thus providing temporary employment as extras for members of the community.

The Tapera community has approximately 200 inhabitants. The economy is focused on family farming of corn and beans during the rainy season, which occurs between February and May (AES-Agência Executiva de Gestão das Águas [Water Management Agency of Paraíba State]). They also use sheep and goat farming as a source of income^{24,25}

Ethnobotanical inventory and socio-economic structure of the Tapera community

The ethnobotanical data on *S. obtusifolium* was acquired through semi structured interviews applied to the householders of the Tapera community in home visits from August to December 2017, following the methodology of Pedrosa *et al.* (2012)⁹. All the 33 houses of the community were visited at different moments; and 69.69% (n=23) of the residents accepted to participate in the research. The interviewees provided information about their socioeconomic characteristics and the type of use, the best place in the community for bark extraction, the method for bark extraction and whether the presence of the EPA influences the bark extraction activity.

The purpose of the study was explained to the community members interviewed, and they were asked to sign an informed consent form, as required by the Brazilian National Health Council through the Research Ethics Committee (Resolution 510/2016). The study is part of a larger project entitled 'Identification of Patterns of Use of Native Species in Caatinga Areas: An Ethnobiological and Conservationist Approach', which has already been approved by the Human Research Ethics Committee (CEP, for its initials in Portuguese) of the Lauro Wanderley Hospital, Federal University of Paraíba, registered under protocol CEP/HULW no. 297/11 (with cover sheet no. 420134).

To determine the level of confidence regarding the use of the species, the Informant Consensus Factor was calculated according to the "fidelity level" of Friedman *et al.* (1986)²⁶, using the formula: $FL = Ip/Iu \times 100\%$, where FL = the fidelity level, Ip = the number of informants who cited the main use of the species, and Iu = the total number of informants who cited the species for any purpose.

Analysis of local availability and extraction of *Sideroxylonobtusifolium*

To identify and record the potential extraction population of *Sideroxylon obtusifolium* around the Tapera community, walks were conducted to the north, west and east (outside the EPA-Lajedo do Pai Mateus boundaries) within the physical perimeter of the community and in its vicinity. The walks were conducted in two shifts (morning and afternoon), with approximately 4 h per shift, totaling 24 h and the walker was always accompanied by a community member, who would indicate the areas that had the largest number of jungleplum trees, following the methodology proposed by Lucena *et al.* (2015)²⁷.

The community area isolated by the fence of the Cariri EPA-Lajedo do Pai Mateus was not analyzed because it is a Conservation Unit and as such, is an area without human interference. The area in the west of the community is characterized by lower vegetation and numerous mesquite trees (*Prosopis juliflora* (Sw.) DC.). The residences are distributed in this region until the entrance of the Pai Mateus Hotel. This area is very anthropized due to the presence of farms and animal breeding. After the entrance of the Pai Mateus Hotel, the houses are mainly distributed on the east side up to the fence of the reserve (Fig. 1). Some areas of the community, a little distant from the houses, are

reserved for coal burning and preparation. The area to the south belongs to the São Francisco community, where no observations were made because this area was not within the perimeter of the studied community.

For each *S. obtusifolium* individual found during the walk, the following parameters were recorded: its diameter at ground level (DGL), taken with a tape measure, with the measurements separated by classes, and its height. The data for the diameter at ground level are presented as the mean±standard deviation. The location of the specimen found was recorded using GPS for constructing the distribution map of the species in the studied region.

For the study of the extractive activity, for each *S. obtusifolium* individual, whether bark extraction was present and the size of any stem scars were recorded. Measurements were performed using a tape measure, checking the height and width of the extraction. The scars of each plant were measured once a month, systematically for 12 months, from August 2017 to July 2018. The 12-month observation was made to record the changes in the number of bark extractions in the dry and rainy seasons in the Community. The extraction area was correlated (Pearson correlation) with the DGL of the plants to evaluate if the residents select the tree used for the extraction based on its diameter (age). The analysis was performed in the software Bioestat 5.3²⁸.

Results

Socioeconomic structure and ethnobotanical study in the Tapera community

Most families comprised 3 to 4 individuals (60.8%), with a similar percentage of men (52.17%) and women (47.82%) in the interviewed population. The age group above 50 years (33.33%) prevailed over the other age groups, with 45.33% of the interviewees between 21 and 50 years and 21.33% between 1 and 20 years. Of the householders, 39.13% were men aged 25-87 years; 30.43% were women aged 40-86 years; and in 30.43% of the households, the men and women contribute to the family income.

The level of education of most interviewees was elementary school I and II or illiterate (73.97%) and only 26.02% had completed secondary education or higher education. Most of the informants (74.3%) have lived in Tapera since they were born and 58.3% have lived in that community for more than 25 years.

All men and approximately 70% of women self-reported as farmers and carry out subsistence farming of corn and beans in the rainy months (30.4%). Because of the low scale of farming, production is used to supply the families that grow them.

Sheep and goat farming (26.3%) by lower-income residents is a way to meet urgent financial needs because the sale of these animals during the driest periods, even though the sales yield low profits, is a quick way to supplement family income.

Some residents, in addition to agriculture and animal farming, make dairy products such as cheese (8.6%) and sell them at the Cabaceiras street market. Furthermore, some (4.3%) use their own homes for selling drinks and food (bar) to complement the family income.

The Fazenda Pai Mateus Hotel is also responsible for providing additional income to some families (21.2%) in the Tapera community, employing mainly the younger residents. When films and soap operas are shot around the Lajedo do Pai Mateus, temporary employment is provided to some residents, either as extras or in the hotel as helpers. However, it is the federal incentives (retirement and family allowance) that provide 73.9% of Tapera residents most of their family income. Most families (65.2%) survive on a minimum wage.

Use of jungleplum by residents of the Tapera community

The species under study, jungleplum, is known by the local population as “quixabeira” and is used by 74% of the interviewees, among whom 41.3% stated that the young people of the community also make use of its benefits. Among those who do not use jungleplum (26%), all said that they know the species. The uses for jungleplum reported by the interviewees were organized into six use categories: forage, technology, food, construction, fuel and medicine, with the uses most frequently cited being food and medicine.

Ten therapeutic indications were recorded (Table 1) and these were associated with four body systems: the urogenital (51.16%), musculoskel *et al.* (34.88%), digestive (9.30%), and nervous (4.65%) systems. Both men and women cited the use of jungleplum as a medicinal plant (Table 1).

The informant consensus factor (fidelity level) was calculated based on the highest therapeutic indication (anti-inflammatory of the uterus) with 10 indications, divided by the total number of informants (23) for all other indications, resulting in a value of 43.47.

Table 1 — Medicinal uses of *Sideroxylon obtusifolium* (ROEM. & SCHULT.) TD PENN in the Tapera community, Cabaceiras, in a semiarid region of Paraíba, northeastern Brazil.

Body systems	Diseases	Form of preparation	Citations	Men	Woman
Urogenital system	Inflammation of the uterus	Make an infusion with the bark, and make a sitz bath	10	40% n= 4	60% n= 6
	Inflammation of the ovaries		6	33.33% n= 2	66.66% n= 4
	Inflammation of the kidneys	Make an infusion with the bark and drink every morning	4	25% n= 1	75% n= 3
	Inflammatory of the urethra		2	50% n= 1	50% n= 1
Musculoskeletal system	Blow	Make an infusion with the bark and drink it or apply it to the painful site	6	66.66% n= 4	33.33% n= 2
	Fall		5	60% n= 3	40% n= 2
	Back pain	Make an infusion with the bark and drink it or use it in "garrafadas" with other barks	4	75% n= 3	25% n= 1
Digestive system	Toothache	Drink the bark infusion	2	50% n=1	50% n=1
	Stomachache		2	50% n=1	50% n=1
Nervous system	Eye pain	Make an infusion with the bark and apply it to the painful site	2	50% n=1	50% n=1

The bark was the only part of the plant cited for medicinal use. The most common form of administration is oral (89.65%), followed by the sitz bath (10.34%). Among the forms of oral administration, "infusion" is most cited (65.38%), where the bark is added to water overnight to release the medicinal substances, followed by "garrafada" (usually a combination of medicinal plants with alcoholic beverages) prepared with water or cachaça together with other plant barks (11.53%) and "lambedor" (a syrup made from medicinal plants and sugar) (8.69%), by cooking the bark with sugar.

The plant branches were used to make firewood, which corresponded with 3.08% of the citations. In the food category, only the raw fruit is cited as edible (27.11%), being considered sweet, tasty and sticky; it sticks to the teeth and lips when ingested due to the presence of latex.

The forage category accounts for 20.33% of the citations, where the branchlets (branches with younger leaves) are used by 41.66%, the fruits by another 41.66% and 16.66% of the respondents use both parts for animal feed and believe that the animals that eat the jungleplum grow vigorous and strong.

In the technology category (5.08%), wood is used as a hoe handle and is considered a good wood because it is resistant to termites. In the construction category, the use for fences was cited three times; however, only the tree branches are used. In this type of use, the branches are removed, as if pruning the

tree, or the residents use the fallen branches found on the ground, which are placed on the existing fence to prevent animals from jumping over it. As the branches have thorns, they stop the animals, especially goats and sheep, from going into other properties. During the monthly monitoring, only one tree was cut for fence construction. However, after cutting the tree, the owner chose to surround the property with barbed wire instead.

Extractive activity

The residents of the Tapera community do not sell jungleplum and only use it when necessary and for personal use. Bark extraction occurs by removing pieces, which are called "shavings" of the bark in the vertical direction of the tree trunk, thus avoiding "rolling the bark" (i.e., cutting around the whole diameter of the stem) to avoid its death (Fig. 2). Even without previous studies, and through only daily observations and acquired knowledge, the community members know that the bark is an important part of the tree. This type of decision can be considered a part of sustainable management of the jungleplum population because the residents are aware that the horizontal extraction of the bark around the trunk can lead to plant death.

When community members were asked about the extraction of bark for sale in street markets, they respond that this no longer occurs in the region. However, they reported that severe exploitation of



Fig. 2 — Extraction of the bark of *Sideroxylon obtusifolium*, (ROEM. & SCHULT.) TD PENN in the Tapera community, Cabaceiras, in a semiarid region of Paraíba, northeastern Brazil

jungleplum bark had occurred in the markets 10 years earlier. Residents reported that villagers and “raizeiros” (herb sellers) of the community were the intermediaries between the bark collectors and the wholesalers, in addition to selling the barks at the street markets in the city center of Cabaceiras.

Although they do not sell the jungleplum, 50% affirm that the presence of the Cariri EPA - Lajedo do Pai Mateus inhibits the extraction of jungleplum bark, due to the almost constant inspection by the Brazilian Institute of Environment and Natural Resources (IBAMA), in addition to the area providing greater visibility for the community through the large influx of tourists and cinematographic productions.

Two priority areas for jungleplum bark extraction were identified: one in a wilder and higher altitude area, referred to herein as Point 1 and the other near the residences (urbanized area), called Point 2, separated by approximately 500 m (Fig. 1). The Tapera residents (69.5%) prefer to remove the bark from jungleplums more distant from residences, in the areas of Point 1, prioritizing adult trees (91.3%) (Fig. 3), which are characterized by the residents as those trees with stronger, thicker bark with more medicinal properties. A distinction was made by the community between adult and young plants based on the stem diameter. Thus, after examining the information from residents regarding whether the plant found was considered young or adult and the

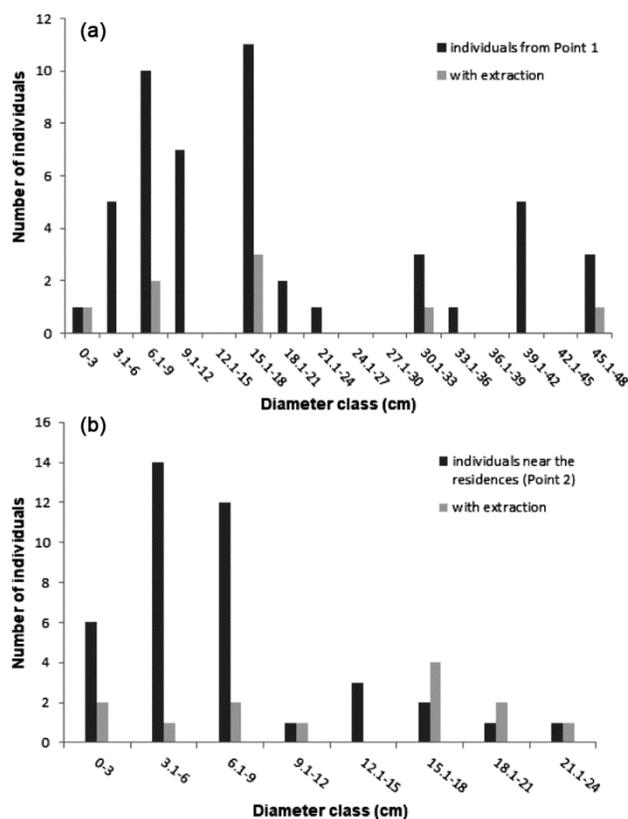


Fig. 3 — Distribution of *Sideroxylon obtusifolium*, (ROEM. & SCHULT.) TD PENN by diameter class and specimens with extraction in the areas of the Tapera community, Cabaceiras, in a semiarid region of Paraíba, northeastern Brazil. A- Distribution in Point 1. B- Distribution in Point 2.

diameter measurements, plants with diameters larger than 16 cm are considered to be adults, and trees with diameters smaller than 16 cm plants are considered young. The men of the community (78.2%) are the main ones responsible for the bark extraction activity.

The severe drought, which lasted approximately 7 years in the period from 2011 to 2017, was also considered by 91.3% of respondents to be partially responsible for the reduction in jungleplum bark extraction because, although it is a drought-resistant species, the residents believe that the species population has been decreasing over the years.

Greater access to health units and (allopathic) pharmaceutical drugs is also considered to be one of the causes of decreased use of jungleplum, where 26% of respondents stated that pharmaceutical drugs work faster and are more effective.

During the walk, 88 *S. obtusifolium* specimens were recorded, 49 (55.68%) located in Point 1, at 420 to 450 m altitude and 39 (44.31%) near the residences (Point 2).

In the area located before the Fazenda Pai Mateus Hotel, 7 individuals were recorded on the west side and 19 on the east side. However, most of the specimens, 62 individuals, were recorded in the northern and northeastern areas of the community. The area of Point 1 has characteristics of dense forest with many tall trees, according to the Tapera residents. An intermittent river, which has been dry for some years (2013-2018), as reported by the residents, is present in the region; nevertheless, the temperatures are milder than in the open areas of the community.

The individuals of Point 1 presented a greater diversity of DGL, from (0-3) to (45.1-48), with few classes in these ranges without representatives. The classes (6.1-9) and (15.1-18) were the ones with the highest number of *S. obtusifolium* at this Point. At Point 2, a lower variation in DGL classes (0-3) to (21.1-24) was observed, with representatives in all classes. The classes with the highest number of representatives were (3.1-6) and (6.1-9).

The individuals with the greatest heights and DGL were recorded at Point 1 (Fig. 3a), in less anthropized areas. The heights of the individuals found in the areas of Point 1 varied between 2.0 to 18 m (8.68 ± 4.01), and the DGLs were between 2.4 to 40 cm (18.48 ± 13.52). On the other hand, the *S. obtusifolium* specimens found in anthropized areas close to residences (Point 2) had heights ranging from 0.30 to 8 m (4.23 ± 1.71) and had DGLs from 0.8 to 22 cm (6.97 ± 4.92) (Fig. 3b).

In the areas of Point 1, both adult individuals and young individuals of *S. obtusifolium* were found, but most (59.5%) were young individuals (Fig. 3a). However, in the anthropized areas near the residences (Point 2), 81.0% of the trees found were young individuals (Fig. 3b).

The observations of the extractive activity in the areas of Point 1 and Point 2 revealed 21 individuals with extraction marks (Fig. 4). Of these, 61, 90% were found in Point 2 and 38, 09% were found near the residences in Point 1.

The size of the scars recorded in the jungleplums closest to the residences in Point 2 ranged from 20 cm to 1 m in length by 10 cm to 30 cm in width. In those analyzed in Point 1, the size of the scars ranged from 20 cm to 80 cm in length by 10 cm to 20 cm in width. Trees with extraction show one or two scars, both in individuals from Point 2 and from Point 1. Although the residents reported that they prioritize adult plants for bark extraction, the correlation showed no

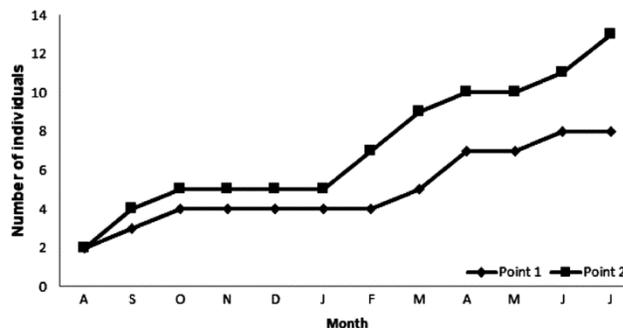


Fig. 4 — Number of *Sideroxylon obtusifolium* (ROEM. & SCHULT.) TD PENN specimens with extraction marks in two areas of the Tapera rural community, Cabaceiras, in a semiarid region of Paraíba, northeastern Brazil

relationship between the DGL and the size of the scars found ($r = -0.1595$; $p = 0.5142$).

Discussion

Socio-economic profile and ethnobotanical study of the Tapera community

In the Tapera community, most interviewees have a low level of or no education. In a community with similar characteristics to those of the Tapera community, in PiauÍ state, northeastern Brazil, older individuals are more prevalent than younger ones, and a low level of education or no education was also more prevalent²⁹. Notably, because it is a community with a prevalence of older individuals who had lower access to formal education, the low level of education can influence the dynamics of the rural society and consequently the income generation of rural populations³⁰. This situation can be modified gradually, as is the case of the communities of the city of Cabaceiras, where city hall provides public schools and transportation so that the rural population can attend the schools located in the urban area of the city. Once the population is in contact with education, understanding develops about the need to improve the use of water, soil and native vegetation³¹.

On the other hand, the lack of education does not mean that the residents of the rural communities do not understand the dynamics of the natural resources that surround them. In contrast, the knowledge gained over the years with respect to the environment where they live allows survival practices to be developed over the time a population resides in the same place³².

In the present study, the main use of *S. obtusifolium* was for medicinal purposes, followed by food, and its use as fuel was the least significant

category. In the São Francisco Community, located approximately 4 Km from the Tapera Community, *S. obtusifolium* was the second-most valued and used species and was placed in the following categories of use: medicinal, food, fuel, technology, and forage, among others³³, as also observed in the current study. In a study carried out in three municipalities of Paraíba, a situation similar to that described for the Tapera community was observed, where *S. obtusifolium* was cited mainly as medicinal, followed by technology and fuel uses⁹. In Serra de Santa Catarina, in the arid region of Paraíba, five use categories were recorded for *S. obtusifolium* among the ten categories considered¹⁴. This shows that jungleplum is an important species for the populations of the studied region.

The importance of jungleplum is not only in the large number of use categories in which it can fall but also in the number of therapeutic indications and in the number of citations the species receives in different regions of the Brazilian Northeast. The Tapera community identified 10 therapeutic indications for jungleplum. In Caruaru, in the Pernambuco state, thirteen therapeutic indications were recorded¹¹, where only vaginal discharge does not fit the indications reported by the Tapera residents. Additionally, 17 therapeutic indications were reported in the study conducted by Pedrosa *et al.* (2012)⁹, of which 6 were not mentioned by the Tapera residents (liver pain, cancer, rheumatism, flu, cough and prostate). In 7 rural communities in the northeastern Paraíba, 289 use citations were recorded for jungleplum²⁹ and in the municipality of Congo 137 citations were recorded³⁰. Moreover, in a study conducted in a rural community in the city of Cabaceiras, 428 citations were recorded²⁵. Notably, the high number of citations for species can be related to their multiple uses and local occurrence of the species being studied²⁵.

The treatments for the various diseases referred to in this study were associated with 4 body systems, among which the urogenital was the most representative, followed by the musculo-skeletal system, with the nervous system being the least representative of all the indications reported by the population. These data corroborate the indications of use for the species in a survey carried out in Serra Branca and Boa Vista, in a semiarid region of Paraíba¹⁵. Similarly, in a study in the Cabaceiras region, Marques *et al.* (2010)¹⁶ shows that the "raizeiros" of the local market (specialist in the sale of medicinal plants) indicates the jungleplum for diseases of the urogenital system.

The informant consensus factor (fidelity level of 43.47) showed that the use of jungleplum as an anti-inflammatory agent for uterus diseases stood out among the therapeutic indications cited. This finding corroborated the study by Agra *et al.* (2007)¹⁵, who reported the use of jungleplum in the treatment of ovarian diseases and the study by Lucena *et al.* (2017)¹⁴, who demonstrated the use of the plant to treat female diseases in Serra de Santa Catarina, Paraíba. Notably, although women are the main users of the plants, the field collection in the Tapera community is mostly performed by the men.

The bark is the only part used in the preparation of the treatments of the affections mentioned in this and other studies^{15,16,34,35,11,9,13}. In the Caatinga plants, the most used part in the preparation of the medicines is generally the bark^{6,7}, a fact that can be explained by prolonged periods of drought, which increases the rarity of other resources provided by the plants¹. Thus, examples of medicinal species native to the Caatinga whose bark is used in the preparation of medicines include "aroeira" (*Myracrodruon unrunderua* Allemão), used for skin injuries and inflammation; *Aspidosperma pyriforme* Mart., used in the treatment of urinary diseases and dermatitis; umbu (*Spondias tuberosa* Arruda), used in the treatment of eye infections¹⁵; mulungu tree (*Erythrina velutina* Willd.), used as a sedative and in the treatment of cough³⁶ and cebil (*Anadenanthera colubrina* Vell.)¹⁴, which is used for wound healing.

The "infusion" is the most common form of preparation of the medicine, which is prepared by placing the jungleplum bark in water overnight, as told by the residents of Tapera. This is also one of the forms of preparation most used by the rural residents analyzed in northeastern Paraíba^{15,9,29}.

The use of "garrafada," prepared with cachaça along with other plant barks, was also observed by Lima *et al.* (2016)¹³. However, studies have found that the population also uses jungleplum bark in the form of tea^{15,9,13}, which did not occur in the present study. This type of use was the main form of preparation in a rural community in São João da Canabrava, Piauí²⁹. The "lambedor" and the sitz bath were also cited as forms of use for the species⁹.

The jungleplum fruit is sweet and juicy and is consumed only raw by the community, similarly to that reported for other municipalities in Sergipe state³⁷. Although the fruit has high agroindustrial potential, the fruit is little exploited both from extraction and planting standpoints. In the caatinga, other fruits are

already commercially exploited, such as imbu³⁷, “fava d'anta” (*Dimorphandra garderiana* Tul.) and pequi (*Caryocar coriaceum* Wittm)³⁹. The jungleplum fruit has little pulp relative to other commercial fruits; however, its production would be compensated by the large amount of fruits produced during the harvest. In this sense, a management and irrigation process adequate for this production could be one of the ways of generating income for the population³⁸. In the case of commercial extractive exploitation, an important concern should be to ensure the sustainability of the species. In regard to extractive exploitation, the unlimited use of natural resources, including fruits, can threaten the maintenance of the local population of the species, affecting the knowledge about its potential¹.

Jungleplum leaves and twigs are cited by community residents as a food source for animals. As observed for other woody species of the caatinga, the animals are allowed to roam (extensive husbandry) in the terrains and end up feeding on the leaves and fruits of the jungleplums plants in the area. “Aroeira” (*Myracrodruon urundeuva* Allemão), amburana (*Amburana cearenses* Allemão) and “catingueira” (*Poincianella pyramidalis* (Tul.) L.P. Queiroz.) also represent examples of forages used in the diet of ruminants in the caatinga³³. Although these plants are important food sources for animals, including their uses during periods of drought, Araújo-Filho (2013)⁴⁰ emphasizes that caution should be exercised in the choice of plants to be used since the presence of tannins may hinder the digestion process of the animals.

In the technology and fuel categories, the main uses are for the production of artifacts used for work, soil preparation (handles of tools such as hoe) and the production of firewood. As recorded by Pedrosa *et al.* (2012)⁹, the Tapera community considers jungleplum wood as appropriate for work applications and resistant to insect attacks; thus, it is a long-lasting wood. In addition, jungleplum is recognized as a less heavy wood than the other woods, facilitating the manipulation of domestic utensils produced from jungleplum.

Jungleplum is used as an accessory to protect fences; this is achieved by placing branches on the fences. This strategy can be used for fences known as “faxina” (wood fence with closely spaced poles) and for fences made with barbed wire. However, a specific study that evaluated the composition of the fences of rural properties of another community in the

Cabaceiras municipality did not record this use of jungleplum⁴⁰.

Extractive Activity

In the Tapera community, men are mainly responsible for bark extraction, as observed in other semiarid communities^{42,15,7,9}. The extraction of the bark from the tree and partial cut of the plant were recorded as forms of extractivism for jungleplum. However, in another study with *S. obtusifolium* in the northeastern semiarid region, another form of extractivism was observed, the total cut of the plant¹⁶.

The Tapera community does not make commercial use of jungleplum bark. The extinction of the root market in the city of Cabaceiras years ago may also have contributed to the change in the dynamics in the trade of plant bark in Tapera. The sale at local and regional markets was already quite common and recorded in a study carried out on the production chain of the species¹⁶.

Although residents report that some use allopathic pharmaceutical drugs, a preference for natural medicines was observed. In the Nilo community in Piauí, northeastern Brazil, the primary healthcare system is poor, and as such, the population relies on home remedies because they are made from the plants available in their yards⁴³. In Gabon, a country in Africa where the population has low financial income, traditional herbal medicines are the most commonly used because pharmaceutical drugs are expensive⁴³. Likewise, a population in the semiarid region of Paraíba describes that natural medicines are healthier and more financially accessible¹⁶.

Young specimens of *S. obtusifolium* are included in bark extraction records, mainly in less urbanized areas (Point 1); these data contradict those reported in the interviews with the residents. However, the extractions that occurred in the trees near the residences were carried out mostly on adult trees. The preference for adult individuals was also reported in the Congo municipality, a semiarid region of northeastern Brazil and showed how aggressive jungleplum bark extraction activity is, which can be debilitating for the plant³⁰. In the Fulni-ô indigenous community, in Pernambuco, the intensive use of *S. obtusifolium* wood significantly reduced the adult population of the species in the community, reducing the reproduction of the species⁸. However, studies in communities of the Paraíba semiarid region observed a preference for the use of young *S. obtusifolium* specimens that showed extraction marks in the

bark and wood⁹, as observed in the municipality of Cabaceiras, which also recorded a preference for adult trees¹⁶.

One of the income sources of the Tapera community is the Fazenda Pai Mateus Hotel, which is linked to the Cariri EPA-Lajedo do Pai Mateus, which generates work opportunities for the community since the hotel involves community residents in their activities, whether environmental or administrative. Although no environmental education interventions were carried out by the Cariri EPA – Lajedo do Pai Mateus directly targeting the Tapera Community, which is one of the requirements of SNUC in paragraph XII⁴⁵, the residents realized how beneficial it is to preserve the environment in exchange for financial return and visibility for the community.

Management and public and private participation in the process of environmental awareness and community involvement are essential for success in conservation initiatives⁴⁵. Conservation units without this vision or support have much more difficulty reaching and raising awareness in the surrounding population. Cases such as these can be observed in the Onças EPA in São João do Tigre, Cariri of Paraíba, which was created in 2002 and does not have adequate management, inspection and environmental educational practices targeted at the local populations. Despite its extreme importance for the Caatinga Biome, this conservation unit has been abandoned by public management⁴⁵. Similarly, EPAs in Zambia, Africa, are also in deplorable conditions, mainly in the ecological, social and financial domains, where the presence of the population in the EPA is leading to environmental degradation and promoting illegal hunting of wildlife⁴⁶.

Thus, the decrease in the extractive activity in the Tapera community may have occurred mainly due to the increased income of the community, as they traded an extractive and exhaustive work, where they received from 400 to 600 BRL monthly or 216 USD (minimum wage value at the time of the study), when they were able to resell the products extracted from the plants¹⁶, for other sources of income that required less physical effort and with less environmental impact.

The Federal Government's incentives are another form of income because as the population of the community grows older, more pensions will be generated, in addition to social benefits such as family allowances that benefit younger families who have children up to 17 years of age who are enrolled in school.

The third cause for the reduction in extractivism is the almost daily presence of IBAMA inspections at the Cariri EPA - Lajedo do Pai Mateus. The residents are afraid of suffering any penalties. On the coast of Rio de Janeiro, a region of high urban development, *S. obtusifolium* was not decimated due to the presence of the Maricá EPA in Grumari Municipal Natural Park and in Restinga de Jurubatiba National Park (Paraná), which undergo constant inspections⁴⁷.

The perception of the Tapera community about the reduction of jungleplum population density in association with climatic changes can be proven when compared to studies in the semiarid region of Brazil, where one of the possible results would be the increase in the average temperature and the decrease in rainfall, expanding the desertification areas and transforming the semiarid region into an arid one⁴⁸. In the Albertine Rift, on the African continent, a modeling analysis estimates that the increase in agriculture, together with climate change, will lead to the disappearance of almost 75% of the natural habitat by 2080, and on average, only 15.5% of the endemic species would survive⁴⁹.

The low density of *S. obtusifolium* recorded, in addition to a low rate of adult individuals in the areas near the residences, may be due to the anthropogenic actions of the residents of the community in the years with great volumes of bark extraction. These data can be corroborated when analyzing bark extraction and tree logging records, which occurred in a predatory manner in the year 2008 in the areas of the Cabaceiras municipality¹⁶. Few adult individuals in a population may reflect the absence or reduction of the species¹ reproduction as a result of excessive extraction from the environment for primarily logging purposes⁸. Anthropogenic actions that result in reduction of biodiversity were also recorded in a study of rural communities in Juazeirinho, Paraíba, where the population itself plays a role in the environmental degradation⁵⁰. The same types of actions occurred on savanna forests in tropical forests in the Middle and High Tietê EPAs, in São Paulo, with agricultural activities and firewood extraction⁵¹.

With regard to the jungleplum biometric analyses, the highest DGL and heights were found in the areas of Point 1, as opposed to the study with the same species that found that individuals in closed forest areas can obtain lower heights and DGL by competing with other species and due to human predatory action⁵². The results obtained in a survey

carried out in Boqueirão, Paraíba, also showed heights and DGL well below those recorded in this study for the areas of Point 1 and even for the areas near the residences⁵³. Likewise, the values were also lower in *S. obtusifolium* individuals from the Fulni-ô population⁸ than in the present study. The heights and DGL were also well below average in the individuals found in the study conducted by Pedrosa et al. (2012)⁹. DGL and height values tend to increase as native environments are more preserved⁵⁴. Analyzing the species by the DGL classes found in this study, we observed a larger representativeness of individuals and better distributed by the DGL classes, than the *S. obtusifolium* individuals from the Fulni-ô population⁸ that were clustered in the classes between (3-17.99).

The Tapera population prioritizes the extraction of jungleplum bark from individuals found in less urbanized areas. Studies carried out in Barrocas and Cachoeira in the municipality of Soledade with the species *Myracrodruon urundeuva* ("aroeira") showed no differences in the extraction site; however, when the extraction is for medicinal use, the residents prioritize the most distant areas of the residences⁷.

The recording of the extent of the extractions only confirmed the information regarding the non-sale of jungleplum bark in the Tapera community, especially considering the proportion of bark extracted per individual, which agrees with those proportions recorded in a community in Pernambuco, showing that the bark extracted represents almost 50% of the total bark of the tree, in most extraction records⁸. The extent of the extractions differs from that observed in the communities of Pereiro in Lagoa, Várzea Alegre, and Barroquinha, in São Mamede, Paraíba, which recorded far more extensive extractions than those observed in the *Tapera community*⁹.

Conclusion

The studied species, *S. obtusifolium*, is considered by the Tapera community to be of great relevance, especially in the medicinal category, which was indicated by the population as having various therapeutic purposes. The bark is the most cited part when referring to medicinal use, and "infusion" is the most common form of preparation.

The predatory extractive activities, regarding bark extraction, showed a marked reduction when compared to studies carried out approximately 10 years ago. This reduction in predatory extractive activity was a result of the partnership between the residents and the Cariri EPA - Lajedo do do Pai

Mateus, the increase in Federal incentives and the increase in inspections in the areas around the Conservation Unit.

The residents of Tapera community do not use a management plan for *Sideroxylon obtusifolium* bark extraction and the extraction system seems not to be influenced neither by the species individual's distribution or by its population structure. We do not identify any *S. obtusifolium* individual highly injured or with any high negative impact level which could affect the individual survivor.

Despite the reduced impact in bark extraction registered in the last years in the region, we suggest a collaborative work with the Tapera community in face to introduce alternative plants that could be used to treat the same ills treated with *S. obtusifolium*. Moreover, *S. obtusifolium* leaves also show to be effective and with similar phytochemical compounds as the bark⁵⁵ and can also be a very efficient strategy to approach the community needs and plant conservation.

References

- 1 Albuquerque UP & Andrade LHC, Conhecimen to botânico tradicional e conservação em uma área de Caatinga no estado de Pernambuco, Nordeste do Brasil, *Acta Bot Bras.* 16 (2002^a) 273-285.
- 2 Lacerda JRC, Sousa JS, Souza LCFS, Borges MGB, Ferreira RTFV, Salgado AB & Silva, MJS, Conhecimento popular sobre plantas medicinais e sua aplicabilidade em três segmentos da sociedade no município de Pombal PB, *Agropec Cien Semiárido*, 9 (2013) 14-23.
- 3 Riegelhaupt EM, Pareyn FGC & Gariglio MA, O manejo florestal como ferramenta para o uso sustentável e conservação da caatinga, In: *Uso sustentável e conservação dos recursos florestais da caatinga*. Brasília: Serviço Florestal Brasileiro (2010) 349-367.
- 4 Kill LHP, Caatinga: patrimônio brasileiro ameaçado, Disponível em: <http://www.agronline.com.br/artigos/artigo.php>, (2002). Accessed on: 20 de fevereiro de 2018.
- 5 Reis CM; Pereira AFN & Cansação IF, Levantamento etnobotânico de plantas medicinais utilizadas por moradores do entorno do Parque Nacional serra da Capivara – PI, *Biofarm*, 13. (2017) 7-21.
- 6 Ribeiro DA, Macedo DG, Oliveira LGS; Santos MO; Almeida BV; Macedo JGF; Macedo MJF; Souza RKD; Araújo TMS & Almeida MM, Conservation priorities for medicinal woody species in a cerrado area in the Chapada do Araripe, northeastern Brazil, *Environ Dev Sustain* (2017) DOI 10.1007/s10668-017-0023-9.
- 7 Lucena RFP, Farias DC, Carvalho TKN, Lucena CM, Vasconcelos Neto CFA & Albuquerque UP,). Uso e conhecimento da aroeira (*Myracrodruon urundeuva*) por comunidades tradicionais no Semiárido brasileiro, *Sitientibus série Ciências Biológicas*, 11(2) (2011) 255-264.
- 8 Albuquerque UP, Soldati GT, Sieber SS, LinsNeto EMF, Sá JC & Souza LC, Use and extraction of medicinal plants by the Fulni-ô indians in northeastern Brazil – implications for

- local conservation, *Sitientibus série Ciências Biológicas* 11(2) (2011) 309–320.
- 9 Pedrosa KM, Gomes DS, Lucena CM, Pereira DD, Silvino GS & Lucena RFP, Uso e disponibilidade local de *Sideroxylon obtusifolium* (Roem. & Schult.) T.D. Penn. (Quixabeira) em três regiões da depressão sertaneja da Paraíba, Nordeste do Brasil, *Biofar*, volume especial (2012) 158-183.
 - 10 Albuquerque UP & Andrade LHC, Uso de recursos vegetais da Caatinga: O caso do Agreste no Estado de Pernambuco (Nordeste do Brasil), *Interciência*, 27(2002b).
 - 11 Monteiro J., Ramos MA, Araújo EL, Amorim ELC & Albuquerque UP, Dynamics of medicinal plants knowledge and commerce in an urban ecosystem (Pernambuco, Northeast Brazil), *Environ Monit Assess*, 178 (2011) 179–202.
 - 12 Lucena CM, Costa GM, Sousa RF, Carvalho TKN, Marreiros NA, Alves CAB, Pereira DD & Lucena RFP, Conhecimento local sobre Cactáceas em comunidades rurais na mesorregião do Sertão da Paraíba (Nordeste, Brasil), *Biotemas*, 25(3) (2012) 279-289.
 - 13 Lima IEO, Nascimento LAM & Silva MS, Comercialização de Plantas Medicinais no Município de Arapiraca-AL, *Rev Bras de Plantas Med*, 18 (2016) 462-472.
 - 14 Lucena RFP, Pedrosa KM, Carvalho TKN, Guerra NM, Ribeiro JES & Ferreira EC, Conhecimento local e uso de espécies vegetais nativas da região da serra de Santa Catarina, Paraíba, Nordeste do Brasil, *Flovet* 9 (2017) 158-179.
 - 15 Agra M, Baracho, GS, Basílio IJ, Nurit K & Barbosa DA, Sinopse da flora medicinal do Cariri Paraibano, *Oecol Bras*, 13 (2007) 323-330.
 - 16 Marques JB, Barbosa MRV & Agra MFE, Efeitos do comércio para fins medicinais sobre o manejo e a conservação de três espécies Ameaçadas de Extinção, em duas áreas do Cariri Oriental Paraibano. In: *Uso sustentável e conservação dos recursos florestais da caatinga*, Brasília: Serviço Florestal Brasileiro, (2010).
 - 17 Leite NS; Lima AP; Araújo-Neto V, Estevam CS, Pantaleão SM, Camargo EA, Fernandes RPM, Costa SKP, Muscará MN & Thomazzi SM Avaliação das atividades cicatrizantes, anti-inflamatória tópica e antioxidante do extrato etanólico da *Sideroxylon obtusifolium* (Quixabeira), *Rev Bras de Plantas Med*, 17 (2015) 164-170.
 - 18 Almeida CFCB & Albuquerque UP, Uso e conservação de plantas e animais medicinais no estado de Pernambuco (Nordeste do Brasil): Um estudo de caso, *Interciência*, 27, (2002) 276-285.
 - 19 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* 113 (2007) 156–170.
 - 20 IBGE (Instituto Brasileiro de Geografia e Estatística). 2017. Available from: <http://www.ibge.gov.br/cidades>. Accessed on: 17/08/2018.
 - 21 Francisco PRM, Classificação e mapeamento das terras para mecanização do Estado da Paraíba utilizando sistemas de informações geográficas, Dissertation (Manejo de Solo e Água) - Centro de Ciências Agrárias, Universidade Federal da Paraíba. Areia, (2010) 122f.
 - 22 Patrício MCM & Araújo SMS, Indicadores socioambientais dos municípios de Cabaceiras e Barra de São Miguel - PB - Brasil: fragilidades e vulnerabilidades à Seca e à Desertificação *Espacius* 37 (2016) 4.
 - 23 Silva JIAO, Barbosa ESL, Silva AGF & Nunes GHF, Unidades de conservação no Semiárido brasileiro: estudo da gestão desses espaços preservado. *Reunir* 7 (2017) 48-66.
 - 24 Lucena CM, Lucena RFP, Costa GM, Carvalho TKN, Costa GGS, Alves RRN, Pereira DD, Ribeiro JES, Alves CAB, Quirino GZM & NUNES EM, Use and knowledge of Cactaceae in Northeastern Brazil. *J. Ethnobiol. Ethnomed.* 9 (2013) 1-11.
 - 25 Silva N, Lucena RFP, Lima JRF, Lima GDS, Carvalho TKN, Júnior SPS & Alves CAB, Conhecimento e Uso da Vegetação Nativa da Caatinga em uma Comunidade Rural da Paraíba, Nordeste do Brasil, *Bol. Mus. Biol. Mello Leitão* (N. Sér.) 34 (2014) 5-37.
 - 26 Albuquerque UP, Lucena RFP & Alencar NL, Métodos e técnicas para coleta de dados etnobiológicos, In: *Métodos e Técnicasna Pesquisa Etnobiológica e Etnoecológica*, NUPEEA, Recife, Brazil (2010) 41–64.
 - 27 Lucena CM, Ribeiro JES, Nunes EN, Meiado MV, Quirino ZGM, Casas A & Lucena RFP, Distribuição local de *Cereus jamacaru* Dc. subsp. *jamacaru* e *Pilosocereus pachycladus* F. Rittersubsp. *pernambucoensis* (F. Ritter) Zappi (Cactaceae) e sua relação com uma comunidade rural no município do Congo, Paraíba, *Gaia Scieedição especial Cactaceae*.9(2) (2015) 97-103.
 - 28 Ayres M, Ayres Júnior M., Ayres DL & Santos AA. BIOESTAT - Aplicações estatísticas nas áreas das Ciências Bio-Médicas. Mamirauá. Belém, PA, 2007, 364.
 - 29 Gomes TMF, Lopes JB, Barros RFM & Alencar NL, Plantas de uso terapêutico na comunidade rural Bezerra Morto, São João da Canabrava, Piauí, Brasil. *Gaia Scie*. 11(1) (2017) 253-268.
 - 30 Souza AS, Souza APB & Lucena RFP, Relative importance of medicinal plants in the Semi-Arid Region of Paraíba: a case study in the Municipality of Congo (Paraíba, Northeast Brazil), *Braz J Biol Scie*, 3 (5) (2016) 3-96.
 - 31 Silva TC; Peroni N and Albuquerque UP, Folk classification as evidence of transformed landscapes and adaptative strategies: a case study in the semiarid region of northeastern Brazil, *Landsc Res*. 42 (2016) 521-532.
 - 32 Eloy CC, Viera, DM, Lucena CM & Andrade MO, Apropriação e proteção dos conhecimentos tradicionais no Brasil: a conservação da biodiversidade e os direitos das populações tradicionais. *Gaia Scientia. Ed. Esp. Populações Tradicionais* (2014) 189-198.
 - 33 Arévalo-Marín E, Lima JRF, Palma ART, Lucena RFP & 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 App*. 14 (2015) 331-344.
 - 34 Roque AA & Loliola MIB, Potencial de uso dos recursos vegetais em uma comunidade rural no semiárido potiguar, *Rev Caatinga*, 26 (4) (2013) 88-98.
 - 35 Barbosa JAA, “Das sementes aos frutos”: indicações terapêuticas dos vegetais e suas partes em uma comunidade tradicional na Paraíba, *Biofar*, 5(2011) 48-63.
 - 36 Alves CAB, Silva S, Belarmino NAA, Souza RS, Silva DR, Alves PRR, & Nunes GM, Comercialização de plantas medicinais: um estudo etnobotânico na feira livre do

- município de Guarabira, Paraíba, Nordeste do Brasil, *Gaia Scie*, 10(4) (2016) 390-407.
- 37 Santos TC, Júnior JEN & Prata APN, Frutos da Caatinga de Sergipe utilizados na alimentação humana, *Scie Plena*, 8 (2012) 1-7.
- 38 Garrido MS, Soares ACF, Sousa CS & Calafante PLP, Características física e química de frutos de quixaba (*Sideroxylon obtusifolium* Penn.), *Rev Caatinga*, 20 (2007) 34-37.
- 39 Silva RRV, Gomes LJ & Albuquerque UP, Plant extractivism in light of game theory: a case study in northeastern Brazil, *J Etenobio Med*, 11 (2015) 2-7.
- 40 Araújo Filho JÁ, Manejo pastoril sustentável da caatinga / João Ambrósio de Araújo Filho, Recife, PE: Projeto Dom Helder Camara, (2013) 200.
- 41 Lima JRF, Nascimento Filho AH, Alves CAB, Nascimento VT, Mourão JS, Oliveira RS & Lucena RFP, Uso y manejo de cercas en una comunidad rural del Semiárido de Paraíba, Noreste de Brasil, *Interciência*, 40 (2015) 618-625.
- 42 Luoga EJ, Witkowski ETF & Balkwill K, Differential utilization and ethnobotany of trees in Kitulanhalo Forest Reserve and surrounding communal lands, Eastern Tanzania. *Econ Bot* 54 (2000) 328–343.
- 43 Batista WFM; Santos KP & Barros RFM, Conhecimento tradicional numa Comunidade rural do nordeste brasileiro, *Gaia Scie*, 11(1) (2017) 225-252.
- 44 Angone SA; Mewono L; Boukandou Mounanga M; Medzegue S; Ella Mendene HF; MbaNdong JG; Djoba Siawaya J F & Souza A, Phytochemical screening and cytotoxicity studies of *Chrysophyllum pruniforme* Pierre ex Engl. Barks, *Pharmacogn*, 5 (2013) 195-199.
- 45 Cunha AHMC, Apa das Onças: Gestão do território e desafios para conservação dos Ecossistemas, Monografia (Graduação em Geografia) - Universidade Federal da Paraíba, João Pessoa, (2011).
- 46 Lindsey PA, Nyirenda V, Barnes JI, Becker MS, McRobb R, Tambling CJ, Taylor WA, Watson FG & t'Sas-Rolfes M, Underperformance of African protected area networks and the case for new conservation models: insights from Zambia, *Plos One*, 9 (2014) 1-14.
- 47 Ferreira R de CN, Espécies arbóreas ameaçadas de extinção das restingas do norte fluminense. Considerações sobre sua conservação mediante ao emprego paisagístico. (Dissertation), Universidade Federal do Rio de Janeiro, Museu Nacional, Rio de Janeiro, (2000).
- 48 Marengo JA, Alves LM, Beponto EA, Lacerda FF, Variabilidade e mudanças climáticas no semiárido brasileiro. In: Recursos hídricos em regiões áridas e semiáridas. Campina Grande, PB: INSA, (2011) 443
- 49 Ayebare S. Plumptre AJ, Kujirakwinja D & Segan D, Conservation of the endemic species of the Albertine Rift under future climate change, *Biol. Conserv*, 220 (2018) 67–75.
- 50 Alves LIF, Silva MMP & Vasconcelos KJC, Visão de comunidades rurais em Juazeirinho/PB referente à extinção da biodiversidade da Caatinga, *Rev Caatinga*, 22(2009)180-186.
- 51 Flynn MN, Louro MPZ, Mendes MSP & Gonzalez RC, Relações Ecológicas entre fauna e flora das áreas de preservação permanente (APP) do Médio e Alto Tiete, Ver Intertox-EcoAdvisor de Toxicologia Risco Ambiental e Sociedade, 8, (2015) 38-93.
- 52 Corrêa MP, *Dicionário das plantas úteis do Brasil e das plantas exóticas cultivadas, Rio de Janeiro, ImprNac, (1985)1926-1978.*
- 53 Silva GMC, Martins PL, Silva H & Freitas KKC, Estudo autoecológico de *Bumelia sertorium* (Quixabeira) - Espécie ameaçada de extinção no ecossistema Caatinga, *Rev Bio Cie Ter*, 4 (2004) 0.
- 54 Santana JAS & Souto JS, Diversidade e estrutura fitossociológica da caatinga na Estação Ecológica do Seridó-RN, *Rev Bio Cie Ter*, 6(2) (2006) 232–242.
- 55 Barbosa DA, Lucena RFP & Cruz DD. Traditional knowledge as basis for phytochemical prospecting of *Sideroxylon obtusifolium* (Roem. & Schult.) T.D. Penn aiming at conservation in the Brazilian semi-arid zone. *Ethnobot Res App*. 18(3) (2019) 1-10.