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Valuation of *Newbouldia laevis* and its endogenous conservation in Benin (West Africa)

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ABSTRACT

The conservation of genetic resources has become a critical task for humanity as it has been realized that these resources are shrinking drastically. This problem is applicable, especially within the Bignoniaceae family, specifically *Newbouldia laevis*, a medicinal and socio-culturally important plant in Benin Africa. Due to its widespread application in traditional medicine in Benin, it has become a form of primary health care for the general populace, therefore making it necessary for scientific research. For this reason, an ethnobotanical survey was conducted in the lower Oueme valley in Benin (West Africa), where people use this plant to cure various diseases, and also for clinical and spiritual purposes. Data acquired by interviewing 785 respondents made up of local healers, herbalists and patients showed that the aerial parts of the plant are the most commonly used, while other parts are rarely used. The most frequently used method of administering the medicinal plant after pharmacological preparation was found to be the oral method. The results also revealed that *N. laevis* was used for treatment of various ailments and has played an important role in the daily lives of people living in the lower Oueme valley in Benin.

1. Introduction

The use of plants as medicine is an ancient practice common to all societies, especially the African society. This practice continues to exist in developing nations. It is on this basis that researchers continue to investigate medicinal plants in order to produce or develop the best medicines for physiological uses (Usman and Osuji, 2007). In West Africa, wild or indigenous plant species are still widely used and many of them are endangered due to various human activities such as logging, cutting and land clearing. An increasing intensity of these activities in combination with drought induces a decreasing availability of grass and tree in savanna ecosystems in West Africa (Scoones, 1995). This problem is applicable especially within the Bignoniaceae family, specifically *N. laevis*, a medicinal and socio-cultural important plant in Benin Africa where it is misused because of exponential population growth and uncontrolled conurbation. Previous phytochemical reports on this species were on the root, root bark, flowers and stem (Burkill, 1985, 2000; Iwu, 2000; Oliver-Bever, 1986) and the literature found on it contains several reports on its phytochemistry, pharmacology and traditional uses (Asase and Yohonu, 2016; Awodele et al., 2013; Chen et al., 2012; Chukwujekwu et al., 2005; Cordell, 2011; Hartati et al., 2014; Komane et al., 2011; Kpodar et al., 2015; Michael, 2008; Mwangi et al., 2016; Nyamukuru et al., 2017; Sánchez-Picó et al., 2014). *N. laevis* is a common tree of West African origin well known for its ethnomedical uses (Dassekpo et al., 2017). One of the main obstacles that hinder the integration of practices associated with religious traditions as tools for biodiversity conservation is the insufficient applicability of research findings in this area. Ethnopharmacological information, depending on the culture and the relationship to “modern” medicine, and the use of associated plants and practices, may or may not be respected and recognized formally as an active and contributing component within a health care system (Cordell, 2014).

Over the past two decades, a substantial proof of evidence linking religious traditions to the conservation of nature has been produced in academia (R. Chambers, 1995; Coe and Anderson, 1996; Dahlberg, 2005; Ehrlich and Ehrlich, 1992; IIED, 2003). However, at the policy level, the integration of these data into conservation planning and implementation remains quite limited. For example, exclusive attention is given to sacred natural sites that are considered protected areas. While this is a commendable achievement, cultural values, which include

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religious traditions, encompass a wide range of social mechanisms that have untapped potential for conservation (Kaimowitz and Douglas, 2007) as they are a form of adaptive natural resource management based on traditional ecological knowledge (Shrestha et al., 2004). Medicinal plants are the backbone of traditional medical practice and indigenous knowledge required for effective herbal medical practice differs between cultures in the different communities (Dassekpo et al., 2017).

N. laevis is a medicinal plant belonging to the family Bignoniaceae. It is native to tropical Africa and grows within the Guinean savannas with dense forests (Matig et al., 1999). It is located in Benin, Nigeria, Senegal, Cameroon, Gabon, Angola and other African countries (Arbonnier, 2002). In Benin, it is known by various indigenous names such as: *Adjaman, Desle, Kpatin, Hounman, Adjatin, Soudeman, Hountin, Ogouman, Aboboeman, Akoko, Ewe Akoko, Alladaboko or Deslesigue*; and it is used by traditional African healers to treat various ailments.

In Benin, herbalists use bark decoction to treat epilepsy and convulsions in children. The leaves are soaked in ethanol for the treatment of diabetes and sickle cell disease. Different parts of the plant have also been reported to possess antimicrobial properties (Eyong et al., 2006; Kuété et al., 2007; Ogunlana et al., 2008). Unfortunately, studies indicate that traditional healers in different societies are diminishing in numbers leading to the danger of the traditional knowledge disappearing rapidly as the young generations in Africa are not interested in traditional practices. Therefore it becomes necessary to acquire and preserve the traditional system of medicine by documenting and correctly identifying specimens (Muthu et al., 2006). This problem should be addressed by investigating the community in regard to resource conservation and management, as well as considering the conceptual origins of the community and the resources they have. The most important part for community advocates is the role the community plays as a small spatial unit in a homogeneous social structure, and the sharing of standards in the management of community resources (R. E. Chambers and McBeth, 1992; Chitere, 1994; Etzioni, 1996).

It is a well-known fact that it is impossible to exploit natural and biodiversity resources indefinitely because they are limited. This continuous and deep erosion of biodiversity resources of which the country contributes to has challenged the conscience of decision-makers at national and local levels. Unfortunately, the promotion of a conservable and sustainable approach in conserving biodiversity resources faces a number of challenges.

This research work focuses on the valuation of *N. laevis* and its endogenous conservation and other traditional practices and religious traditions that influence its use as a ritual plant, including taboos, sacrifices, relic forests and private botanical gardens. *N. laevis* (P. Beauv. Seeman ex Bureau) is a widely used species but unfortunately has little documentation of its endogenous traditional usage. The species is also well known for its leaves being able to alter the behavior of people. This characteristic has been traditionally exploited for centuries in Africa which helps the local people in many traditional practices. It is therefore urgent to investigate the probable effects on the geographical distribution of the species in order to deduce the habitats favorable for the domestication of the species in regard to its sustainability and conservation by the local populations. In line with previous efforts therefore to document the conservation of *N. laevis* and its method of preparation, a survey was conducted in the lower Oueme valley with the purpose of understanding the use of *N. laevis* in the community through the different pharmacological compositions and to connect it with the conservation process for an existential perpetuation of the species in order to guarantee its sustainable development.

2. Methods

2.1. Study species

This study is mainly focused on *N. laevis* (P. Beauv). This plant is a medium sized angiosperm which belongs to the Bignoniaceae family. It grows to a height of about 7–8 (up to 15) meters, more usually a shrub of 2–3 meters, with many stems forming clumps of gnarled branches (Arbonnier, 2004). It is native to tropical Africa and grows from Guinea Savannahs to dense forests, on moist and well-drained soils. It inhabits the secondary forest extending from Senegal to Cameroon, Gabon, Democratic Republic of Congo and Angola (Arbonnier, 2004). Table 1 shows the vernacular names of the species according to ethnic group.

Table 1
Local names of *N. laevis* according to ethnic group.

Ethnic group	Local name
Fon	*Aboboeman, Desle, Desle-siguè*
Goun	*Adjaman, Adjatin, Kpatin*
Nago	*Ewe akoko*
Setto and Toli	*Houman, Hountin, Soudetin, Soudeman*
Weme	*Desle, Houman*

2.2. Study area

The study was carried out among local populations in the lower Oueme valley (Fig. 1). The lower Oueme valley includes the following towns: Adjohoun, Aguegues, Bonou, Dangbo and Sô-Ava. Its name originated from the Oueme river which, before plunging into the lagoon of Porto-Novo, has created a real inner delta which at the same time is its floodplain. It is long, nearly 50 km, and broad, approximately 25 km, and appears as one of the most beautiful geographical landscapes in Benin.

It consists of three distinct parts: A floodplain housed inside a basin, a rim of the plateau, the bulk of which is formed by the alluvial terraces and a plateau of the continental terminal overlooking the valley. These various parts cover an area of 1.236 km^2 and are populated by 379.207 persons (INSAE, 2013) distributed in 160 villages mentioned in the five communes above. The population density averages 215 inhabitants per km^2 and the average farm size is 1.60 ha, and it is a region with strong hydro-agricultural potential (L.A.R.E.S, 2001). The lower Oueme extends between 6°27′ and 6°54′ north latitude and east to west between 2°27′ and 2°33′ east longitude. It is bounded to the north by the department of Zou, south by the northern shore of the lagoon (Nokoue lake and lagoon of Porto-Novo) where it flows to the east by the tray of Sakete and west by the marshes of the river of Sô. Three important elements characterize the region: the valley, the river and the lagoon from which the people derive the bulk of their production (Bossa, 2000).

2.3. Survey involvement

The extent of use of the plant species was obtained through the retrospective survey method. This study was conducted in six ethnic groups located in five townships of lower Oueme valley in Benin, namely Adjohoun, Aguegues, Bonou, Dangbo and Sô-Ava. The sample size of each ethnic group was determined by taking into account the representation of the ethnic groups within the overall lower Oueme valley people. Men and women belonging to the different ethnic groups (Fon, Goun, Weme, Nago, Setto and Toli) were randomly selected, with ages ranging from 20 to 90 years. In each household, one or two persons willing to participate in the investigation were interviewed

2.4. Survey design and analysis

Information was collected through two methods: focus group discussions and individual interviews. All focus group discussions were organized within the Fon or Goun ethnic groups. The focus groups allowed interviewers to gather information on the various uses of the target species and the organs used. The five main being medicinal,

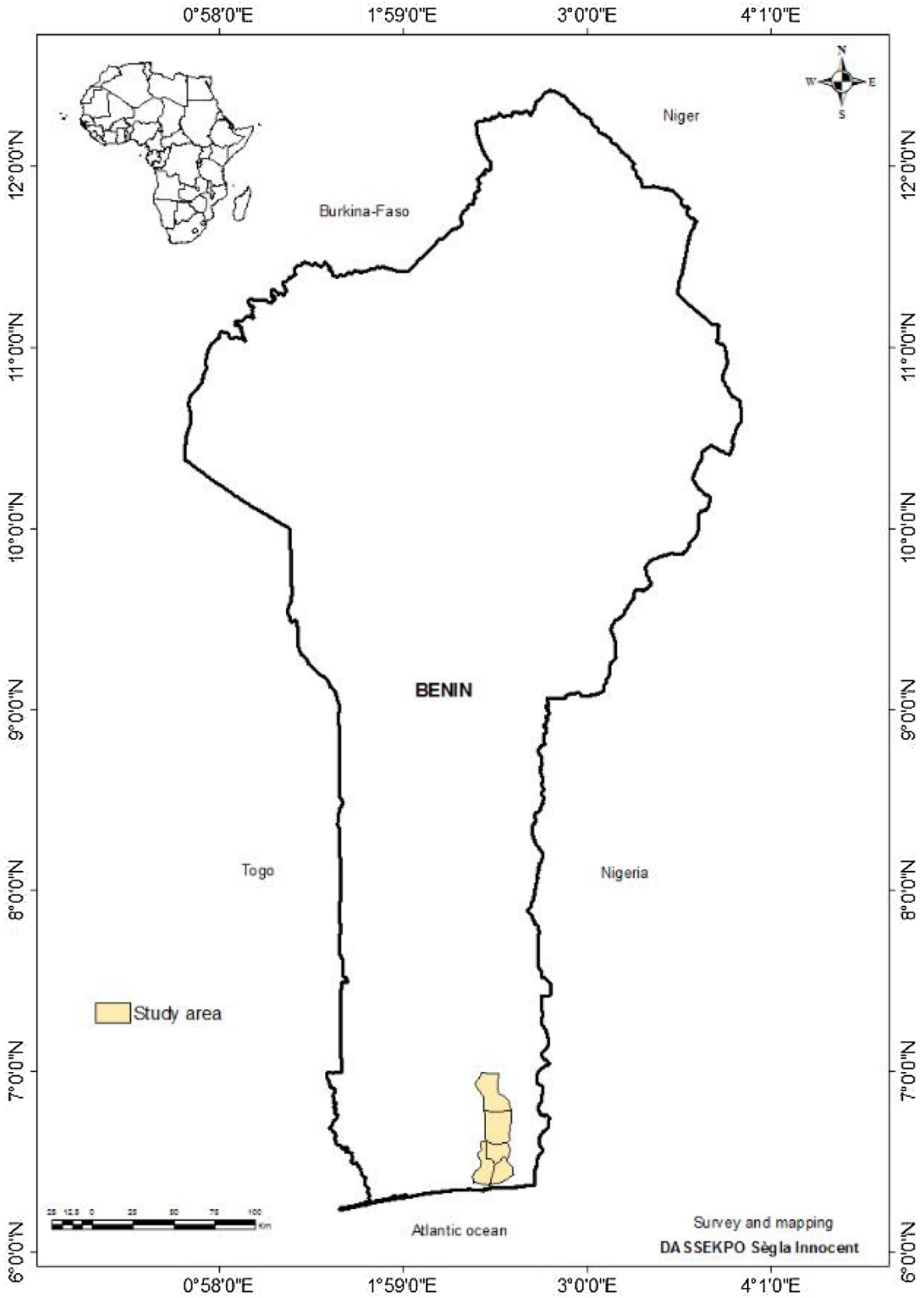

Fig. 1. Study area (Oueme lower-valley in Benin).

fodder, fuel, craft and religious purposes The traditional ecological knowledge that may eventually improve the species conservation was also identified during the focus group discussions. The focus group discussions allowed the authors to understand that local people have traditional knowledge on the methods for thinning out of leaves, debarking and uprooting the species, and therefore individual structured

questionnaires were developed in order to commence the second phase of the data collection process. Interviews were conducted in the local language of the informants with translators when needed. Prior consent was taken from informants before each interview and participants were clearly informed about the objectives of the study and their right to withdraw from the study at any time. Each focus group was made up of 5–15 participants aged from 20 to 90 years. Informants were interviewed over the decline of the target species, their uses and their method of exploitation that might have led to the current species' conservation status. Individual structured interviews were conductd with 785 people randomly selected from those living in the surroundings of the lower Oueme valley. The respondents used in this paper were healers, herbalists, plant sellers and patients who had concrete experience and knowledge in the use of *N. laevis* for the treatment of a range of diseases. The interviews helped to acquire information about the ethnomedical use of *N. laevis*, modes of preparation, practices in the treatment of various diseases and the species' conservation modes.

A structured questionnaire was used to collect data on sociocultural characteristics of the respondents and on the uses of the target species. Informants were asked to answer the questions related to its usage, their knowledge about the decline of species and the sustainable use of species. After collecting the information from interviews and questionnaires, a literature review was conducted on the known traditional and medicinal properties of the species. Afterwards, questionnaire responses were compiled in Excel (Microsoft Office 2010), and the dataset analyzed in R (3.0.2) software. Table 2 shows the characteristics of each research sample, the number of participants per study category and the participant's socio-culture and gender.

3. Results and discussion

3.1. Aerial aspect of N. laevis in the Oueme lower-valley

In all surveyed areas, *N. laevis* is one of the most widely used plants in Africa, especially in Benin. It is a greenish-leaved plant with a height of about 7–8 meters in general but can reach up to 20 m in the study area, and also in the lower valley of the Oueme (Fig. 2). With age, *N. laevis* ends up with bright dark green leaves with large violet flowers with whitish contours. People in Benin generally consider this tree as the tree of life, the tree of fertility or the divine tree. The wood is pale brown, durable, even textured and hard and it tends to stay alive for a long time even after being cut. *N. laevis* has different symbols and represents different things in different countries. In lower Oueme valley, Benin, as in many African countries, it has been given different names.

Fig. 2. Physical aspects of *N. laevis* in Oueme lower valley, Benin.

3.2. Ethnobotanical approaches and use of N. laevis

3.2.1. Self-medication and traditional methods of preparation

In lower Oueme valley community, individuals buy or go to harvest plant parts they already know and the vast majority do not seek medical advice. In all cases, the dosages are recorded based on individual experiments without fear of the toxicity of the plant part. The various plant parts of *N. laevis* are used as medicine which vary according to the preparation.

This study revealed four main traditional methods of preparation for *N. laevis* which was sometimes combined with other plants:

·Boil (infusion and decoction) the leaf, bark or root of *N. laevis*. The potion is often administered orally.

·Dip (maceration) often bark or root of *N. laevis* placed in cold or hot water and the extract used for various purposes.

·Spray (cold powder often produced by manual grinding of the leaf, bark or root of *N. laevis*). The powder is used for specific therapeutic purposes and is often eaten and sometimes used for scarifications;

·Ignite (hot powder or igniting of the leaf, bark or root of *N. laevis*). Black powder is mainly used for scarification; it is rarely used orally.

The analysis showed that boiling represented the most used method of preparation (48 %) followed by the practice of igniting (25 %). Apart from these two practices, dip (maceration) covered 16 % followed by spraying (11 %) (Fig. 3).

3.2.2. Administration modes based on phyto-pharmacological compositions

There are several ways in which the preparations of *N. laevis* are administered in the community:

Table 2
Research sample and number of participants per study category, their socio-cultural and gender characteristics.

Ethnic group	Fon		Goun		Nago		Setto		Toli		Weme		Number of respondents	Age			Statistical significance (%)
Respondents category	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women		Age group	Number by age group	Year of experience	
Traditional healers	15	2	16	3	8	2	9	1	13	3	32	1	105	Young (age≤35)	13	10≤age≤15	13.38
														Adult (35≤age≤60)	28	35≤age≤40	
														Old (age≥60)	64	35≤age≤50	
Herbalists	24	1	21	1	5	0	14	0	16	1	35	2	120	Young (age≤35)	17	8≤age≤21	15.29
														Adult (35≤age≤60)	46	30≤age≤40	
														Old (age≥60)	57	35≤age≤50	
Plant sellers	0	9	2	7	0	4	0	6	1	10	5	34	74	Young (age≤35	14	7≤age≤25	9.43
														Adult (35≤age≤60)	49	25≤age≤40	
														Old (age≥60)	11	30≤age≤50	
Insiders	12	1	8	0	7	3	9	0	13	1	31	5	90	Young (age≤35)	4	5≤age≤30	11.46
														Adult (35≤age≤60	30	30≤age≤55	
														Old (age≥60)	56	age≤55	
Patients	14	8	18	21	7	11	18	33	25	37	93	111	396	Young (age≤35	98		50.44
														Adult (35≤age≤60)	175		
														Old (age≥60)	123		

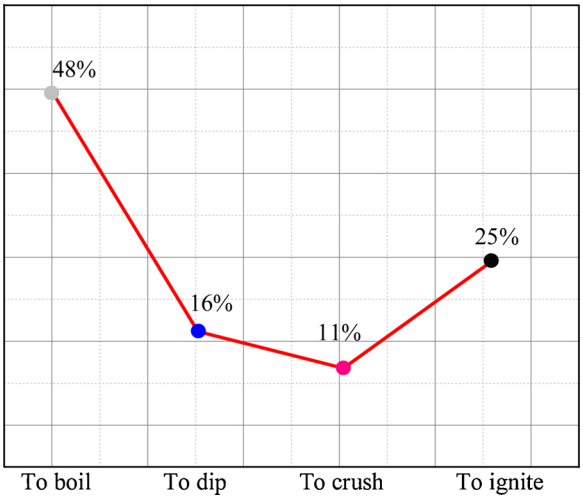

Fig. 3. Traditional methods of preparation of phyto-pharmacological compositions.

·Oral: The broth of *N. laevis* leaves is directly drunk by the patient, sometimes preceded by incantatory words.

·Medicinal fumigation: Generally, the leaves and other ingredients of the pharmacological composition, including those of *N. laevis* and other plants are boiled. The vapours are administered by steam inhalation. With a cloth draped over their head the patient inhales slowly and deeply through the nose for several minutes.

·Lotion powder: the *N. laevis* powder is mixed with shea butter or any product from a range of petroleum jellies, or mixed with other lotions and applied by the dermal route. The powder resulting from the calcination of the parts of *N. laevis*, sometimes in combination with other plants, is either taken orally or applied by scarification. This is a common form of administration.

·Body bath: The patient takes a shower with a warm or cold preparation of *N. laevis* at a recognized ritual place which is sometimes accompanied by incantations;

·Mouthwash or gargle: A warm decoction of the leaf, bark and root are used as a mouthwash.

·Sitz bath: Lukewarm decoction of *N. laevis* leaves combined with other plants and minerals, are used as a shallow bath for the patient sit in.

The statistics of *N. laevis* routes of administration are shown in Fig. 4. The oral route (75 %) and bathing (18 %) were the most used, while fumigation, scarification and the dermal routes fell below 5% (3%, 2% and 2% respectively). It should also be noted that some people make eye drops using the juice of the young leaf of *N. laevis*.

3.3. N. laevis organs used

Almost all the plant parts of *N. laevis* are used but in varying degrees. As shown in Fig. 5, leaves (84.33 %) are the most widely used with roots (12.49 %) the second most used. This practice is highly

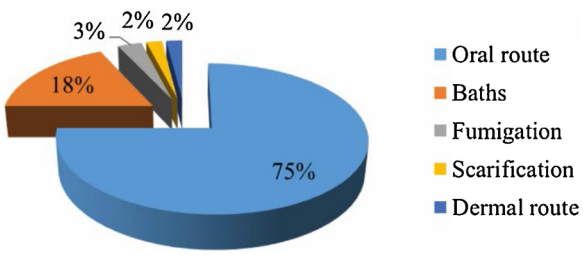

Fig. 4. Administration modes based on phyto-pharmacological compositions.

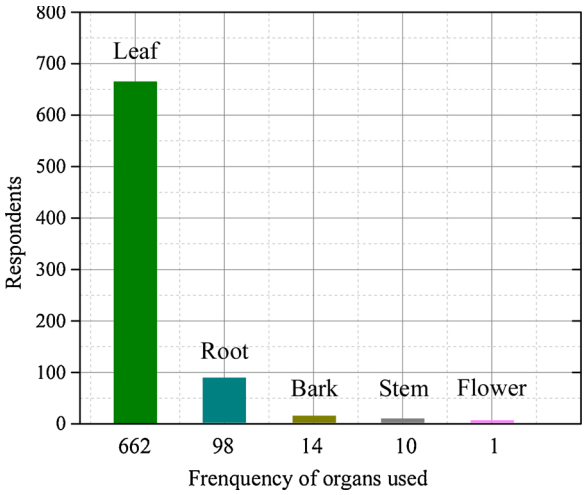

Fig. 5. Chart describing the *N. laevis* organs used.

detrimental to most plant species in general and is not any different for *N. laevis* since it results in the death of the plant. Sometimes the whole plant is grubbed and thus its survival is saved. The bark represents 1.78 % of the parts used and the stem 1.27 %. The flower is rarely used.

3.4. N. laevis and pathology treatment

N. laevis is widely used in traditional medicine and sometimes in traditional ceremonies in the lower Oueme valley (Table 3). The leaves, bark, stem and roots are used in the treatment of conjunctivitis, arthritis, dysentery, enlarged spleen, heart burn, wounds, ear and stomach ache, sore feet, chest pain, epilepsy and children's convulsion (Burkill, 1985, 2000; Iwu, 2000; Oliver-Bever, 1986). The anti-inflammatory, antipyretic, analgesic and anticonvulsant properties of the stem, bark and flowers have also been studied (Olajide et al., 1997; Tanko et al., 2008a; Usman et al., 2008). Different parts of the plant have also been shown to exhibit antimicrobial, antimalarial, sedative, anti-inflammatory, anti-nociceptive, anti-diabetic, uterine contractile and antioxidant properties (Ainooson et al., 2009; Amos et al., 2002; Bafor and Sanni, 2009; Eyong et al., 2005; Gafner et al., 1996; Kuete et al., 2007; Ogunlana et al., 2008). Recent phytochemical analysis of the root, root bark and stem of this plant showed the presence of alkaloids, quinoids, ceramides and phenylpropanoids (Adesanya et al., 1994; Aladesanmi et al., 1998; Gafner et al., 1996, 1997; R Gormann et al., 2003; R. Gormann et al., 2006; Houghton et al., 1994; Kuete et al., 2007).

3.4.1. The leaf

The filtrate of *N. laevis*' leaves obtained after trituration is used to treat eye conditions such as ophthalmia and conjunctivitis. A decoction of the leaves in palm oil soup is taken by pregnant women to help delivery and use after childbirth to promote a rich production of breast milk. The ash-reduced leaf, mixed with salt, is considered a remedy for heart pain. A decoction of the leaves, combined with those of *Psidium guajava* mixed with kaolin, is taken in the treatment of diarrhea and dysentery. The chewed leaves are also applied to the wound of a snake bite, to suck out the venom.

3.4.2. The bark

According to this survey, the bark is a pain reliever. A decoction is used in the treatment of coughs, diarrohea and dysentery, while it is also given to children for the treatment of epilepsy and seizures. A bark decoction, combined with small peppers, is used in the treatment of chest pain. The dried bark with young twigs of the oil palm, pounded with spices like *Xylopia sp*, is given as a decoction or infusion to treat

Table 3
Pathologies showing the number of participants per socio-cultural and gender characteristics.

Plant part used	Ethnic group / Pathology	Fon		Goun		Nago		Setto		Toli		Weme		Age	Number	Total	Statistical significance (%)
		Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women				
Leaf	Ophthalmitis	30	2	26	9	7	1	5	-	9	4	29	29	Young (age≤35)	15	151	19,23
														Adult (35≤age≤60	88		
														Old (age≥60)	48		
	Conjunctivitis	12	7	46	34	75	46	37	16	27	39	88	53	Young (age≤35)	203	480	61,14
														Adult (35≤age≤60	177		
														Old (age≥60)	100		
	Childbirth	11	56	6	53	21	55	6	61	13	45	19	67	Young (age≤35)	123	413	52,61
														Adult (35≤age≤60)	159		
														Old (age≥60)	131		
	Diarrhea	23	12	34	2	12	23	13	5	17	3	9	6	Young (age≤35)	77	159	20,25
														Adult (35≤age≤60)	49		
														Old (age≥60)	33		
	Dysentery	7	3	12	17	26	47	11	3	16	-	24	37	Young (age≤35)	127	203	25,82
														Adult (35≤age≤60)	58		
														Old (age≥60)	18		
	Snake bite	6	-	4	-	19	11	-	-	8	3	10	3	Young (age≤35)	11	64	08,15
														Adult (35≤age≤60)	20		
														Old (age≥60)	33		
Bark	Painkillers	10	3	14	9	5	2	9	5	2	-	14	6	Young (age≤35)	18	79	10,06
														Adult (35≤age≤60)	46		
														Old (age≥60)	15		
	Cough	7	3	11	8	3	-	7	6	-	2	5	-	Young (age≤35)	11	52	06,62
														Adult (35≤age≤60)	18		
														Old (age≥60)	23		
	Diarrhea	19	23	45	25	14	11	33	17	13	7	35	39	Young (age≤35)	154	281	35,79
														Adult (35≤age≤60)	78		
														Old (age≥60)	50		
	Dysentery	13	22	36	33	13	21	32	17	18	33	37	56	Young (age≤35)	137	331	42,16
														Adult (35≤age≤60)	119		
														Old (age≥60)	75		
	Dysmenorrhea	12	49	8	57	17	34	21	63	11	41	31	69	Young (age≤35)	203	413	52,61
														Adult (35≤age≤60)	169		
														Old (age≥60)	41		
	Hoarseness	38	33	47	52	71	68	36	43	37	39	73	84	Young (age≤35)	268	621	79,10
														Adult (35≤age≤60)	216		
														Old (age≥60)	137		
	Dermatosis	8	13	39	32	21	23	14	14	24	20	34	42	Young (age≤35)	159	284	36,17
														Adult (35≤age≤60)	81		
														Old (age≥60)	44		
Root	Constipation	12	11	23	17	3	11	32	28	35	23	36	32	Young (age≤35)	129	263	33,50
														Adult (35≤age≤60)	96		
														Old (age≥60)	38		
	Abscess	15	17	19	21	22	13	36	23	23	11	27	31	Young (age≤35)	113	258	32,86
														Adult (35≤age≤60)	93		
														Old (age≥60)	52		
	Stomach ulcers	7	13	20	17	31	19	6	28	34	11	35	30	Young (age≤35	105	251	31,97
														Adult (35≤age≤60)	119		
														Old (age≥60)	27		
	Arthritis	2	5	12	11	9	14	2	6	7	7	14	21	Young (age≤35)	12	110	14,01
														Adult (35≤age≤60)	53		
														Old (age≥60)	45		
	Otitis	3	5	9	7	15	11	-	5	11	8	31	18	Young (age≤35)	21	123	15,66
														Adult (35≤age≤60)	79		
														Old (age≥60)	23		
	Intestinal worm	23	34	19	14	45	31	12	19	16	12	29	13	Young (age≤35)	153	267	34,01
														Adult (35≤age≤60)	67		
														Old (age≥60)	47		
	Abdominal hernia	5	3	9	-	17	3	4	2	3	-	15	1	Young (age≤35)	21	62	07,89
														Adult (35≤age≤60)	33		
														Old (age≥60)	8		
	Swelling of the legs	21	13	14	6	23	16	11	5	16	12	23	21	Young (age≤35)	51	181	23,05
														Adult (35≤age≤60)	90		
														Old (age≥60)	40		
	Arthritis	18	11	11	3	19	8	2	-	12	5	17	9	Young (age≤35)	10	115	14,64
														Adult (35≤age≤60)	45		
														Old (age≥60)	60		

uterine cramps and dysmenorrhea. When applied externally, the bark is used to heal a range of dermatoses, including septic wounds, abscesses and ulcers, and is also used to treat snake bites. Reduced into powder and then converted into a paste, the bark is applied to rheumatic and arthritic joints, especially painful arthritis of the knee. The soft bark, lightly protected in cotton, is put in the ear to ease otitis.

Table 4
Uses of *N. laevis* in the treatment of diseases within the community.

Treatment/Properties	Specifications
Stimulating uterine contraction	*N. laevis* is used as an oxytocic, which is explained by the fact that it is effective in inducing labor in women during childbirth. In addition, research by (Bafor and Sanni, 2009) shows that aqueous extracts and *N. laevis* ethanol can stimulate uterine contraction in rats. This suggests why some traditionalists in African countries use this leaf to trigger labor, facilitate birth or protect the young embryo. *N. laevis* can also be used to remove the placenta after delivery. The community believes that when pregnant women take *N. laevis* leaf and bark cooked in palm oil soup, it helps facilitate delivery and promote lactation and breast milk supply after childbirth.
Arthritis and rheumatism	Bark and leaves are used for the treatment of arthritis and rheumatism.
Laxative	*N. laevis* acts as a laxative by using its bark which can be combined with the seeds of *Carica Papaya*
Digestive disorders	*N. laevis* can be used to treat patients with diarrhea and dysentery.
Bactericidal	The phytochemical analysis of the stem bark showed the presence of flavonoids, tannins, saponins and alkaloids. The study revealed that the bark of the stem of *N. laevis* has antibacterial activity (Akerele, Ayinde, & Ngiagah, 2011).
Oedema	The bark of *N. laevis* and its roots are used to treat swelling and edema resulting from food deficiency
Eyepiece and auditory	The leaf extract is used for both eye treatments and otitis.
Antidote	*N. laevis* is used as an antidote to palliate insect bites and poisonous bites.
Epileptic treatment	Some traditionalists use the bark, roots and leaves of *N. laevis* to treat patients with epilepsy, paralysis, convulsions and spasms. The leaves and bark can be prepared as a decoction to treat children suffering from epilepsy and convulsions.
Antibactericidal	*N. laevis* is an anti-bactericidal so is used as an antibiotic.
Dysmenorrhea	*N. laevis* is prepared as an infusion or decoction for the treatment of colic dysmenorrhea and uterus.
Constipation	The bark of *N. laevis* is used for the treatment of stomach diseases such as constipation.
Analgesic properties	The leaves of *N. laevis* has analgesic properties; Thus, when the dried bark is crushed in combination with *Piper Guineense* and Salt, it is used to treat headaches, sinusitis and migraine.
Chest pain	The bark combined with small red chili pepper is used to treat chest pain.
Toothache	*N. laevis* extracts can be gargled to treat toothache.
Antimalarial	*N. laevis* is also used to treat patients suffering from malaria.
Cough	The bark of *N. laevis* boiled in palm wine or water can be used for the treatment of a cough.
Dermatology	The stem of *N. laevis* and its bark are used to treat infections of the skin due to its antifungal properties.
Gastric ulcers	The leaf reduced to ashes when mixed with salt is taken as a cure for gastric ulcers.
Veterinary care	The bark, roots and leaves can be used together to feed sheep, as anthelmintics and to improve their appetite (Hounzangbe-Adote, 2000).

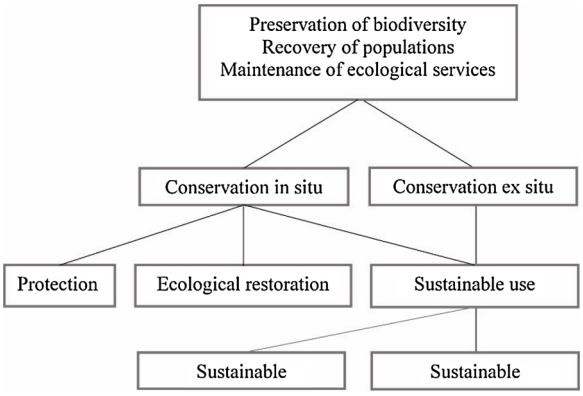

Fig. 6. Conceptual scheme of conservation principles (Limoges et al., 2013).

3.4.3. The root

A decoction of pounded roots is used to treat intestinal disorders. A macerate or decoction of the roots is taken orally as a dewormer to rid the digestive tract of roundworms, and is also used to treat hernia and syphilis. The treatment is also purgative and is considered to be more or less toxic. Applied externally, the softened root is also used as a poultice to treat sore limbs. Root scrapings, combined with small red peppers, are spread on decayed teeth. Combined with *Afromomum melegueta* and pounded with spices like *Xylopia aethiopia*, the roots are used for massage of edematous areas of the body resulting from food deficiency or shock. In refractory cases of arthritis, where walking has become almost impossible, various parts of *Prosopis africana* are added to an aqueous infusion of *Ocimum canum* and the root of *N. laevis* for internal and external use.

3.4.4. The leaf-bark pair

This combination is used when calcined and reduced to powder for easy wound healing. The bark and leaf are used for the treatment of arthritis and rheumatism and as pain reliever after powdering and mixed with neutral ointment.

3.4.5. The leaf-root combination

The roots and leaves are often combined and mixed with spices as a remedy for elephantiasis of the scrotum, or for any form of orchitis using a decoction where the ingredients are pounded and applied lukewarm. Combinations are also thought to have aphrodisiac properties. Boiled, it is administered as a febrifuge.

3.4.6. The triad leaf-bark-root

The leaf-bark-root combination is used for night baths, mostly by Setto and Toli ethnic groups living in the geographical area of the lower Oueme valley.

Table 3 shows the number of participants treated with *N. laevis* for a range of pathologies. From this research, it can be seen that *N. laevis*, is also used as an oxytocic, has antibacterial, nalgesic, dermatological properties and used to treat a wide range of diseases. The community also acknowledges *N. laevis* as a mysterious plant.

3.4.7. Specific uses of N. laevis

The characteristics of *N. laevis*, the routes of administration and the parts used to treat various conditions in communities in the lower Oueme valley have been described in this study (Tables 3 and 4). A total number of 785 people was interviewed and of these, patients who were undergoing or had undergone treatment with *N. laevis* constituted the largest percentage (50.44 %). The high proportion of patients and herbalists is an indication of the popularity of the herbal medicine, especially the use of *N. laevis* in the community of the lower Oueme valley. Regarding the methods of administration, the oral route (75.2 %) was the most used, while bathing, fumigation, scarification, and the cutaneous route were less popular. The leaves of the plant are most frequently used and administered directly in the form of decoctions, macerations and infusions and in some cases applied by the dermal route.

3.4.8. Conservation spirit in anthropic-endogenous practices and integrated approach to sustainable development

Almost all plant parts of *N. laevis* are used but in varying degrees. The leaves however are generally the most used and represent the main part whose effectiveness is indisputable. Research in some recent

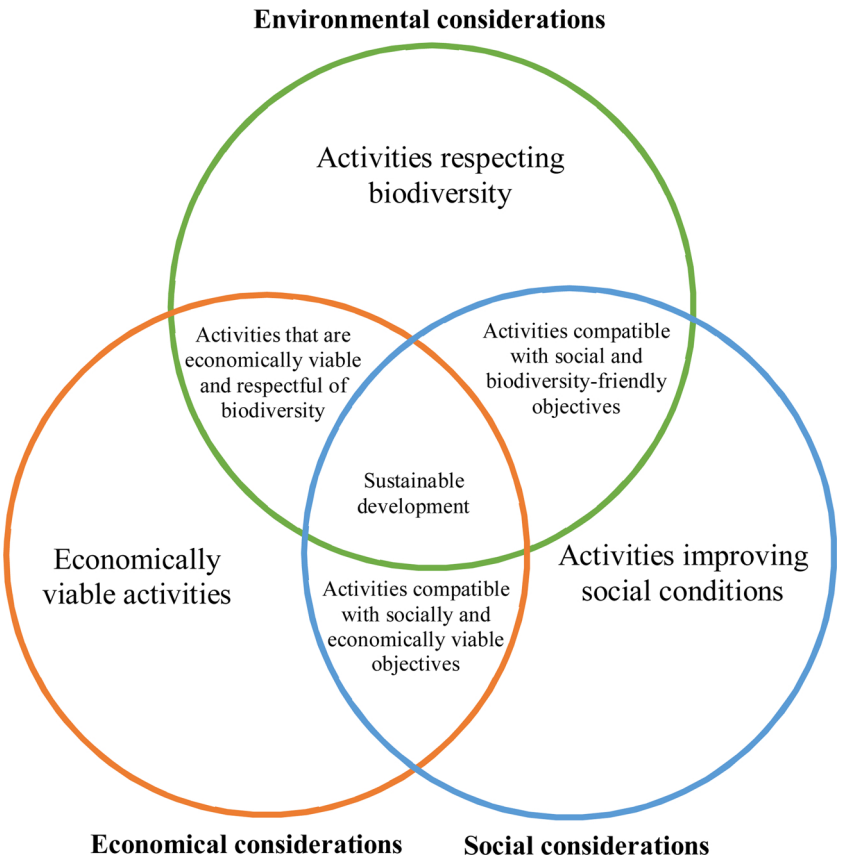

Fig. 7. Conservation of biodiversity in the context of sustainable development (M.E.R.F., 2003).

Fig. 8. Pictures showing the different endogenous practices that contribute to conserve *N. laevis*.
a, sacred site with deity b) Traditional selling venue
c) Picket fence d) Electric stake

studies has raised concerns that the stress of excess leaf collection will cause serious consequences for the dynamics of reproduction, which then affects the population dynamics and causes reproduction problems for future generations, and sustainability.

Conservation can be summed up as a set of practices that include protection, restoration and sustainable use of resources that aims to conserve biodiversity, recover species or maintain ecological services for present and future generations. This definition voluntarily includes sustainable development since these concepts are included in the sustainable use. It takes into account the spirit of conservation in the study area and is in line with Fig. 6. To address the conservation of biodiversity the populations of the study area opt for several alternatives, most of which are endogenous and effective. The sacralization of forests offers several advantages such as low cost of forest cover monitoring through fear and awareness of the presence of divinities that are rewarded only by low-value offerings for example, chicken, oil, cornmeal, or cola. They are islands for the conservation of ecological controls and places of refuge and conversation of some animal and vegetable species (MEHU, 2002). For this model of sustainable development to succeed, it must consider the political and institutional context at the local, national and international levels and allow the integration of social, environmental and economic considerations into development, as illustrated in Fig. 7.

In the study area, the sites shown in Fig. 8 is where certain trees are transformed into sacred places for sacrifices and offerings to *vodoun*. This is the case for trees such as *N. laevis, Dracaena arborea, Spondias mombin, Chlorophora excelsa, Cola nitida* and*, Garcinia kola.* Some people in the local communities in Benin consider *N. laevis* as a "god" and do not believe in a possible extinction which would mean the demise of a deity. These trees are thought to be inhabited by spirits whose access is reserved only to the insiders and therefore must not be destroyed by anyone or at any time. Many species are considered as deities, an important factor of the endogenous conservation exercise. It is important to mention that the nature of the fetish species depends on the socio-ethnic group and the religious rites of the region.

In addition, several multi-purpose plant species are planted around houses for use as fence supports made of straw or branches of trees such as oil or coconut palm. These plants are generically referred to as " *Kpatin* " literally " *fence tree* ". This is the case of *N. laevis, Dracaena arborea, Spondias mombin, Moringa oleifera, ficus spp* and *Bombax brevicuspe*,. Thus, forest relics are found in many villages in Benin and the resources they contain are preserved based on their being sacred, that is to say, the rules and principles of spirituality. Respect for the inviolability of sacred forests is a positive attitude that promotes the protection of the environment and the conservation of biological diversity. The "*Hèkpazoun*" relic forest located in the village of Agbanou, commune of Allada and the forest "Agbogbozoun" with its spiritual river “Hlan” of Gbénou-Hlanhonou, commune of Zogbodomey, are typical examples. In the Oueme department, a fabric of red cloth or an oil palm branch represents a prohibition. When attached to a tree, this canvas or twig prevents the destruction of the tree, even in the field or in the bush. The involvement of beliefs in environmental management has always been beneficial for the environment and for men’s well-being and in the exercise of sustainable development.

4. Conclusion

This survey revealed that populations in the lower Oueme Valley use *N. laevis* to treat a wide range of diseases since time immemorial, although traditional medicine practitioners in these communities may be unaware of the bioactive constituents of the plant they generally prescribe. Scientific evidence from the literature suggests that these prescriptions may be effective against the indicated diseases. However, this study of *N. laevis* in this community gives the impression that scientific evidence is not required for this plant to confirm its therapeutic efficacy against the indicated diseases and to validate its use in the traditional medical practice of people in the lower Oueme valley and other people from different communities in Benin.

Nevertheless, it would be beneficial for biochemical studies to be carried out so that its active ingredients are tested on different pathologies and consistent dosages indicated for all plant species commonly used in the area. Beyond the salutary concern to conserve the biological resource, it is necessary for the society to recognize this need for conservation so that it can curb the current tendency for the degradation of the vegetal cover which will result in misuse caused by population growth.

Credit author statement

According to the research group regulation, the authorship credit should be based only on:

1- Substantial contributions to survey, conception and design, or acquisition of data, or analysis and interpretation of data;

2- Drafting the article or revising it critically for important intellectual content; and

3- Final approval of the version to be published.

The authorship contributions for the manuscript entitled “Valuation of Newbouldia laevis and its endogenous conservation in Benin (West Africa)” are as follows:

Survey
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Experimental test and acquisition of the data
Innocent Sègla Dassekpo
Analysis and interpretation of the data
Innocent Sègla Dassekpo, Enoch G. Achigan-Dako
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Innocent Sègla Dassekpo, Brice Tenté
Drafting of the article
Innocent Sègla Dassekpo
Critical revision of the article for important intellectual content
Christophe S. Houssou, Adam Ahanchédé
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Christophe S. Houssou, Adam Ahanchédé

Declaration of Competing Interest

The authors declare that there are no conflicts of interest.

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