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Inventory, folk classification and pharmacological properties of plant species used as chewing stick in Benin Republic

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Chewing sticks are secondary forest products used by people of all ages, genders and professions in Benin but less investigated according to species concerned, their importance according to local communities and their pharmacological properties. For that purpose, an ethnobotanical survey was conducted among 105 local informants of 8 districts in southern and central Benin. The informants were requested to list the species used as chewing sticks and to rank them by priority. To assess pharmacological importance, phytochemical screening was done on four species listed as priority according to local perceptions. The most important plant families of chewing sticks harvested are *Euphorbiaceae, Combretaceae, Anacardiaceae*, *Rubiaceae* and *Rutaceae*. We recorded 35 species of chewing sticks which were grouped into three categories. Six major groups of chemical compounds were tested in four species listed as priority: alkaloids, tannins, flavonoids, saponins, steroids, terpenoids and heteroside cardiotonics. Chemical groups found in selected plants have in general positive actions on dental care, but some such as heterosides cardiotonics found in *Pseudospondias microcarpa* (in traces) are not recommended because of the risks of cardiotoxicity known for these chemical compounds.

Key words: Chewing sticks, chemical compounds, *Pseudospondias microcarpa*, cardiotoxicity.

INTRODUCTION

Non-timber forest products (NTFPs) play an important role in the livelihood of rural and urban people around the globe (Griffiths et al., 2003; Emanuel et al., 2005; Gaoue and Ticktin, 2007). For example, many NTFP's with medicinal value are harvested for local healthcare needs as well as for sale in national and international industries (Stewart, 2003; Hamilton, 2004). However, the growing demand for NTFPs used for both subsistence and commercial trade (Hamilton, 2004; Botha et al., 2004) has, in has, in many cases, led to unsustainable management of forest resources (Peres et al., 2003; Botha et al., 2004). The Convention on Biological Diversity (CBD) mandates that contracting parties, preserve and maintain knowledge, innovations and practices of indigenous peoples and local communities for the conservation and sustainable use of biological diversity. This requires a better understanding of natural resources available and already integrated into the cultural norms of rural people.

Chewing sticks are secondary forest products used by people of all ages, genders and professions throughout Africa. In Benin, it is a cultural practice transferred between generations and an inexpensive option for oral hygiene (Akpona, 2007). It is also a key resource

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Table 1. Information on Sex, Age, Zone and Profession of the Respondents.

Criteria	Category	Number of respondents		
Sex	Men	63		
	Women	42		
Age	Old persons (≥ 40 years old)	70		
	Young persons (< 40 years old)	35		
Zone	Rural	66		
	Urban	39		
Profession		Wholesalers	Retailers	Total
	Traders	16	44	60
	Traditional healers	7		
	Others	38		
Total		105		

because it provides substantial income and provides sanitary, medicinal and pharmaceutical benefits for communities. Presently many species that are used for this purpose are highly threatened in Benin. According to Djossou (1985), the functional justification of vegetable toothbrush is related to its four roles: cleaning of dental surfaces (mechanical action), gingival massage (activetion of blood circulation), oral asepsis (phytotherapy) and stimulation of parodontal structures. This suggests that plants used as chewing sticks have phytochemical properties still not justified by pharmacists. However, little is known about biological and pharmacological properties of chewing sticks as a consequence of the little documentation available on the species used as chewing sticks in Benin. This study aims to

(a) Identify species used as chewing sticks in Benin.
(b) Understand folk classification and prioritization of concerned species.
(c) To identify chemical components of the most important species and their importance in dental hygiene.

MATERIALS AND METHODS

Study area

Republic of Benin is located at the so-called Dahomey-Gap, in which the savannah extends as far as the sea, through a hiatus in the West African rain forest over some 200 Km from South East Ghana to South East Benin (Whitmore, 1990; Martin, 1991; Maley, 1996). This study was conducted in the Guinean region: from about 7°N 9°10'N (South of Abomey latitude) to about 8°N (at Savè latitude). The districts of Savè, Abomey, Savalou and Dassa (Centre Benin) and Comè, Cotonou, Porto-Novo (southern Benin) were surveyed. The mean temperature is constantly high (25°C) with daily amplitude below 5°C in the South and 10°C in the North. The weather in Benin is characterized, these past years, by a high variation in annual rainfall from one year to another and within each year. Southern Benin has a subequatorial climate subdivided into four seasons of unequal length: two rainy seasons (from April to July and September to October), and two dry seasons (from November to March and end of July to August). In Benin republic, the vegetation is characterized by a great variety and a fragmentation of habitat caused, on the one hand by climatic, topographic and edaphic factors and, on the other hand, by human influence on the environment. There are no evergreen tropical forests or rain forests in Benin. At the same time, there is an increasing population pressure on natural ecosystems to satisfy the need for fuel wood, construction, medicine, etc. In the South, the remaining forest patches include the Lama Reserve and Pobè relict forests (Sokpon, 1995). In Central Benin, natural forests have been cleared and replaced by a mosaic of savannas and dry forests. Southern Benin represents only 10% all the country and gathers at least 50% of the Beninese population with densities lower than 150 inhabitants with the km² (da Matha San' T Anna, 2001). In the centre, density is approximatively 38 habitants/km² (INSAE, 2002) Figure 1.

Inventory, identification and prioritization of chewing sticks' species

The inventory and prioritization of chewing sticks species according to local perception were assessed through interviews. Ethnobotanical surveys were conducted among local people of 8 districts in Southern and central of Benin. The sampling method was non-random, and the informants were pre-defined (Albuquerque and Paiva, 2004) using indications and orientations from local communities. A survey based on structured questionnaire and focus groups discussions was carried out on 105 persons of various socio-professional groups (Table 1). Different ethnic groups were considered (Fon, Goun, Mina, Tchabè and Idaatcha). Respondents were composed of the people of the two sexes belonging to all the categories of age suggested by OMS (1974). 60% of informants were considered from rural villages and 40% from urban centres. Indeed, according to PAFT (1987), the percentage of rural populations using the chewing sticks is higher than the percentage of urban centres and could even exceed 80%.

Respondents were asked to make a free listing of species used as chewing sticks and rank them by priority. Provision sites were also recorded for each listed species. Initially, the respondents listed all the species used as chewing sticks. Then, it was requested from each person interviewed to mention the five main species used from the most important to the less important. We selected the four most important and used species taking into account the budget planned for the phytochemical screening which could cover only four species. Sixty nine respondents were considered for the prioritization exercise considering that many of them (essentially urbans) do not know enough species and could not identify the species name (local or scientific).

For each quoted species, local name was recorded and the species was sampled during field trips with the informant. Species

Table 2. Protocol of chemical groups characterisation

Chemical groups	Specific reagent	Reaction
Alkaloids	Mayer (potassium iodomercurate)	Yellowish precipitate
Tannins	$FeCl_3$	Coloration blue-bed, green or black
Flavonoids	Shinoda (reaction to the cyanidine)	Orange, red colouring or violet
Quinoid derivatives	Bornträger (reaction between quinoid cycles in NH_4OH environment)	Purplish red
Saponins	Determination of the foam index (IM)	Positive if IM>100
Steroids and Terpenes	Liebermann-Burchard (Acetic anhydride H_2SO_4 (50:1)	Coloration blue, green or violet
Heterosides cardiotonics	1%dinitrobenzoïc acid in EtOH + 1N NaOH (1:1)	coloration red crimson
Cyanogenetic Derivatives	Guignard (impregnated paper of picric acid)	chestnut colour
Essential oils	Drive with the vapour	sense of smell

sampled were identified by botanists of the Laboratory of Ecology Applied and National Herbarium of Benin.

Phytochemical Screening of four most important chewing sticks species identified by local communities

We collected leaves samples from the most important chewing sticks species as indicated by the respondents for phytochemical analysis. Samples were ground into powder material and analyses were done following method by Houghton and Raman (1998).

Phytochemical analysis consists of qualitative determination of the following components in collected samples: alkaloids, tannins, flavonoids, quinonic derivatives, the saponins, steroids and terpenoids, cardiotonic heterosides, cyanogenetic derivatives and essential oils (Table 2). These chemical compounds are recognized for their antibacterial (tannins, flavonoïds, essential oils), anti-inflammatory (flavonoids, saponins, essential oils, steroids and terpenoids), analgesic (saponins, steroids and terpenoids), anaesthetic (alkaloids), antiseptic (tannins, essential oils), anti oedema (saponins), and healing (tannins, essential oils) properties (Houghton and Raman,1998).

RESULTS AND DISCUSSION

Diversity and classification of chewing sticks' species in Southern and central of Benin

Chewing sticks in Benin Republic belong to a diversity of families of which *Euphorbiaceae, Combretaceae, Anacardiaceae*, *Rubiaceae* and *Rutaceae* are the most important (Figure 2). *Rubiaceae* and *Euphorbiaceae* are included in the most ecologically dominant families in Benin (Adomou et al., 2007). Our results suggest a probable correlation between families' abundance and selection of families used for medicinal purposes. According to this assessment, the more a species is abundant in an area the more its medicinal uses are known.

Thirty five species of chewing sticks were recorded in the study area and categorized using local classification based on the sources of provision, healing properties and knowledge of each cultural area. Three categories were defined considering local perceptions and traditional knowledge of Benin communities. The category 1 consisted of species imported by sellers from neighbouring countries (Ivory Coast, Ghana and Togo). Category 2 consisted of species collected and marketed locally and category 3 contains harvested chewing stick species that were not marketed (Table 3).

The specific richness of chewing sticks species obtained in the southern and the central of Benin is not so different with the record of Arbonnier (2002) who identified for chewing sticks purposes 40 species in the dry zones of West Africa. However all the species inventoried during this study except for *Zanthoxylum zanthoxyloides, Dialium guineense, Pteleopsis suberosa, Phyllantus muellerianus, Ochna subscorpioides, Citrus* sp., *Bridelia ferruginea* and *Anogeissus leiocarpus* were not inventtoried by Arbonnier (2002). About 70 species of woody plants are used in Ghana as chewing sticks (Blay, 2004). The list of species of chewing stick should be rather dynamic since the rural populations use new species in case of drastic reduction of species currently used for this purpose. Our study includes new species in this list of Arbonnier (2002) and this could be improved by investigated the northern part of the country. There is certainly a crucial lack of data to be developed and capitalize in each country of West Africa.

Prioritization of chewing sticks species

The percentage of positive response in the listing of chewing sticks' species is in the following order: *Garcinia sp.* (83%), *Pseudocedrella kotschyii* (54%), *Napoleona vogelii* (51%), *Pseudospondias microcarpa* (51%) and *Zanthoxylum zanthoxyloides* (48%). According to the classification based on local perception, 86% of respondents consider those five species in the list of priority species. 14% of respondents included three other species (*Anogeissus leiocarpus, Rothmania urcelliformis, Sorindea warneckei*) in the list of the five priority species. The species of the genus *Garcinia* regarded as priority by the populations is the only one of category 1. It is known

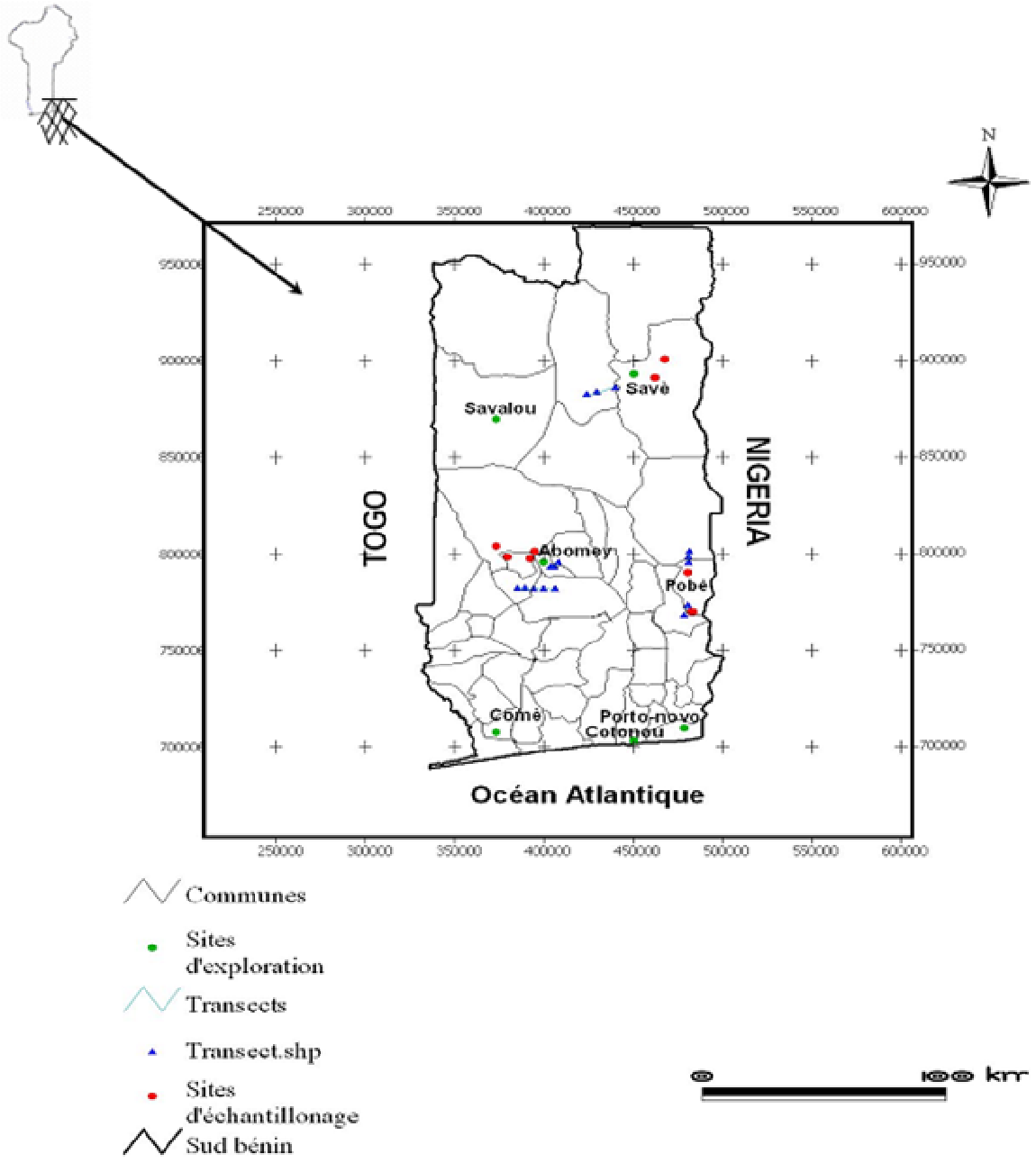

Figure 1. Study area

under various names: *Ghanalo*, *Lomèlo* or *Côte-d'ivoire lo* which indicate their source (example, *Ghanalo* means the chewing stick came from Ghana). Indeed, this *Garcinia* sp. is marketed in Ghana and Togo. The trade and use of chewing sticks are very widespread in Togo. In Southern Togo the genus *Garcinia* (species *gnetoïdes* and *polyantha)* of the family of *Guttiferae* growing in dense forest is more requested (FAO, 2001). Considering the deforestation in the forest area of Togo, the two species mentioned above are rare and consequently, all of chewing sticks presently used are imported from the neighbouring Ghana (FAO, 2000). In Ghana, the best chewing sticks in terms of quality come from 'tweapea' (*Garcinia kola*) and 'nsokar' (*Garcinia epunctata*) trees (Blay, 2004). In Benin, traders recognized that *Garcinia sp.* comes from Togo and Ghana. This emphasized the concept of chain in marketing due to the scarcity of this species. If the sticks of *Garcinia sp.* do not have an indigenous local name like the majority of the species of category 2, this presupposes that the populations are not familiar with the species because of its scarcity. There are some wild species of *Garcinia* but only one is domesticated and locally called *Ahowé* (Fon and Goun) and *Orogbo* (Yoruba) in Southern Benin.

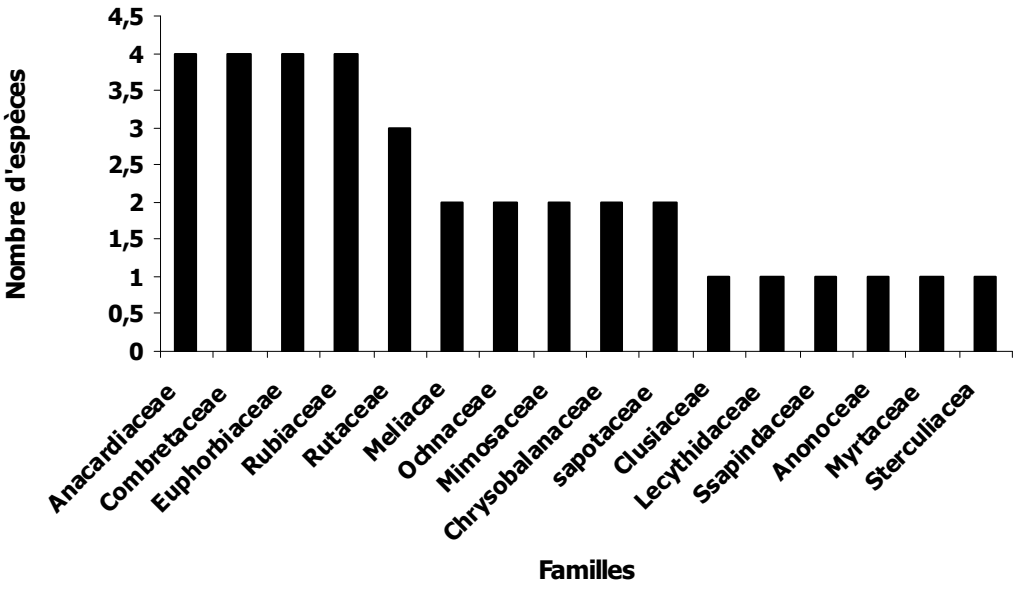

Figure 2. Importance of Family of Species used as Chewing Sticks.

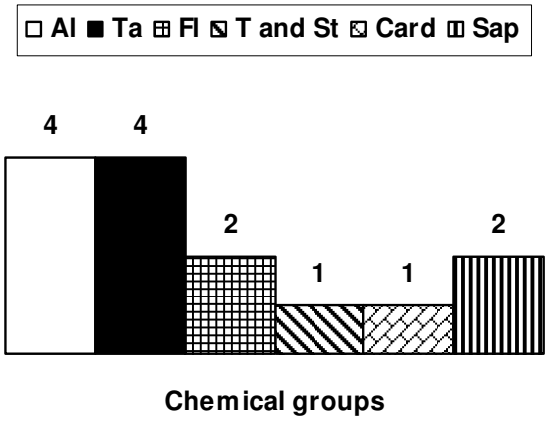

Figure 3. Importance of Chemical Groups in Plants.

According to the flora of Benin Republic, the probable species are *Garcinia kola*, *Garcinia livingstonei*, and *Garcinia smeathmami* (Akoègninou et al., 2006). Chewing sticks based on *Garcinia* sp. are brought in from the neighbouring countries while the other four priority species are collected and marketed locally. This justified the choice of *Pseudocedrella kotschyii*, *Napoleona vogelii*, *Pseudospondias microcarpa* and *Zanthoxylum zanthoxyloides* for the phytochemical analysis.

Biological and pharmacological properties of four most important chewing sticks species

Six major groups of chemical compounds were found in our samples: alkaloids (Al), tannins (Ta), flavonoids (Fl), saponins (Sap), steroids and terpenoids (St and T) and heterosids cardiotonics (Card) (Table 4). Tannins and alkaloids are the chemical groups most frequent and they were found in the four species (Figure 3). These are followed by saponins and flavonoids present in 50% of the plants. Steroids and terpenoids are present in only one plant (*Pseudospondias microcarpa*). Moreover, heterosides cardiotonics with genuine cardenolides were found in traces in the same species. Anthocyanins, leucoanthocyanidins, quinonic derivates and cyanogenic derivates are absent in all plants concerned by the phytochemical analysis. *Pseudospondias microcarpa* contains the others groups (alkaloids, tannins, terpenoids and steroids) which have positive actions on dental care. However, the presence of traces of heterosides cardiotonics is dangerous. This is because of the risks of cardiotoxicity known for these chemical compounds. Therefore, the use of chewing sticks containing heterosides cardiotonics must be avoided.

Anti-inflammatory, analgesics and local anaesthetic properties found in the chemical compounds could be profitable in the dental gingivitis, pains and some inflammatory affections of the oral cavity. Disinfectants and antibacterial properties could be profitable for infections of the oral cavity (Table 5).

The use of the plants as chewing sticks originated from the Greeks and the Romans but is still practiced in parts of Africa, Southern Asia, Tropical America and among some populations of Indians in Northern America (Chaaib kouri, 2004). In a survey carried out by MacGregor (1963), it was observed that tribes in Ghana prefer plant based chewing sticks to the modern brushes. Indeed, a large number of these plants possess antibacterial, antifungal, anti-tumor, anti-inflammatory or analgesic properties. *Zanthoxylum zanthoxyloides* is especially

Table 3. Ethno-botanical diversity of the species of vegetable brush.

	Species	Local nommenclature			
		Ethnic groups	**Fon**	**Nagot**	**Goun**	**Yoruba**
Category 1	*Garcinia* sp.	Ahowé		Kpako	Ahowé	Orogbo
Category 2	*Zanthoxylum zanthoxyloides* (Lam.) Zepern.andTimber	Hêtin		-	-	Igui ata
	Napoleona vogelii Hook. and Planch.	Zèdou		-	-	-
	Pseudocedrella kotschyii (Schweinf.) Harms	Atindokpé		Tchaguigui	-	Tchakisi
	Pseudospondias microcarpa (A. Rich.) Engl.	-		-	-	Ito
	Dialium guineense Willd.	Asswènssweèn		-	-	Eweanyi
	Sorindea warneckei Engl.	Adouhouadouhoua		-	-	-
	Ochna scweinfurthiana F. Hoffm.	Adjahimèlo		-	-	-
	Olax subscorpioides Oliv.	Amitin ; Mitoun		-	-	Ifan ;èla
	Lecaniodiscus cupanioides Planch.	Ganhotin		Akika	Ganhotin	Akika
	Allophylus africanus P. Beauv.	Allo-viaton		-	-	-
	Terminalia glaucescens Planch. Ex Benth. «	Alotoun,		-	Anagossiti	-
	Combretum collinum Fresen.	-		Gbodomi	-	-
	Anogeissus leiocarpus (DC.) Guill. and Perr.	Hlihlon		Ayi	Hlihlon	Ayi
	Bridelia ferruginea Benth.	-		-	-	-
	Hymenocardia acida Tul.	-		Okpa	-	-
	Entada africana Guill. and Perr.			Akakayi	-	-
	Maranthes polyandra (Benth.) Prance	-		Tchowoco	-	-
	Rothmania urcelliformis (Hiern) Robyns	-		-	-	Egui oliyéré
Category 3	*Clausena africana*	Gbodouzohouin		-	-	-
	Citrus aurantifolia (Christm. and Panzer) Swingle	Clé		Ossin	-	-
	Monodora tenuifolia Benth.	-		-	-	-
	Azadirachta indica A. Juss.	Kininoutin				
	Psidium guayava L.	Kinkountin			Yovolènkoun	
	Entada gigas (L.) Fawc.and Rendle					Antoyi
	Lannea humilis (Oliv.) Engl.					Iran adjé
	Malacantha alnifolia (Baker) Pierre					Akala
	Vitellaria paradoxa C.F. Gaertn.	Houngo		Emin		Emin
	Phyllantus muellerianus (Kuntze) Exell			Ahoudjin		
	Microdesmis puberula Hookk. f. Ex. Planch.					Idoun kpata
	Waltheria indica L.	-		Nondi nondi	-	-
	Nauclea latifolia Sm.	-		Igbèssin	-	-
	Sarcocephalus latifolius (Sm.) E. A. Bruce	-		Eokodjikassi	-	-
	Parinari curatellifolia Planch. Ex Benth.	-		-	-	-
	Pteleopsis suberosa Engl. and Diels	-			-	-

recognized by African healers (Chaaib kouri, 2004). Indeed, *Z. zanthoxyloides* is used as an internal and external parasiticide. The roots of this plant are particularly appreciated as chewing stick. This study undertaken on *Z. zanthoxyloides* did not show any toxicity of the whole plant by oral and for the other modes of administration but according to Pousset (1989), this toxicity is very low. The bark of the stems, as well as the sheets appeared less toxic (Neuwinger, 1996), which means that the use of *Z. zanthoxyloides* (Lam) is not harmful to human health.

Terminalia glaucescens does not show negative compounds on human health. In the Central and North of Togo, it is especially the roots of *Terminalia glaucescens* that are mostly used (FAO, 2000).

Other species such as *Napoleona vogelii, Pseudrocedrella kotschyii* and *Anogeissus leiocarpus* are strongly used for their importance in the treatment of oral diseases. Moreover, the species *Ochna scweinfurthiana*, already listed by Arbonnier (2002) for the treatment of fever, malaria and furuncle is also identified during investigations and is highly commercialized.

The majority of species used as chewing sticks in

Table 4. Phytochemical screening.

Species / Chemical groups	*Napoleona vogelii*	*Pseudospondias microcarpa*	*Pseudocedrella kotschyii*	*Zanthoxylum zanthoxyloides*
Alkaloids	++	++	+/-	++
Tanins	++	++	+++	++
Flavonoids	-	-	++	+/-
Anthocyanins	-	-	-	-
Leuco -anthocyanidins	-	-	-	-
Quinonics derivatives	-	-	-	-
Terpenoids and Steroids	-	++	-	-
Heterosides cardiotonics	-	+/-	-	-
Saponins	++	-	++	-
Cyanogenic glycosides	-	-	-	-

–: negative results ++: clearly positive results
+: positive results +/–: traces

Table 5. Properties of chemical compounds present in the plants.

Chemical groups	Main biological and pharmacological properties
Alkaloids	Action of local anaesthesia
Tanins	Healing, anti-bacterial, antiseptic, antioxidant, enzymatic inhibition: 5-lipo oxygenase
Flavonoids	Anti-inflammatory, anti-bacterial, antiviral in vitro.
Saponins	Anti-bacterial, antiseptic, antiviral.
	Anti-inflammatory, anti-oedematous and analgesic.
Terpenoids and Steroids	Antiviral, analgesic, anti-inflammatory and antiseptic.
Heterosides cardiotonics	Cardiotonic : positive inotrope, negative chronotropic, negative dromotrope, Cardiac toxicity

Benin has a diversity of medicinal properties which are related to dental hygiene. However, the medicinal uses listed by rural populations for the majority were not pharmacologically tested to validate the remedies indicated. The phytochemical screening was carried out on four species which represent only 11% of the non-exhaustive species richness of chewing sticks' species in Benin.

Complementary surveys are thus recommended to identify, purify, and isolate the compounds from these chemical groups present in the plants and to study their efficacy in the treatment of certain infections of the oral cavity. It is also suggested that ethno-medical study of these vegetable drugs be carried out.

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REFERENCES

Akoègninou A, Van der burg WJ, Van der massen LJG (2006). Flore analytique du Bénin. Backhuys Publish. Cotonou & Wageningen. p. 1034

Adomou AC, Sinsin B, Akoègninou A, van der Maesen LJG (2007). Vegetation patterns and environmental gradients in Benin: implications for biogeography and conservation. Notes of the Laboratory of Applied Ecology 2(1): 4

Akpona TJD (2007). Ethnobotanique, commercialisation et statut écologique des espèces de brosse végétale dans les formations naturelles du Sud et centre Bénin. Mémoire d'Ingénieur des Travaux. Ecole Polytechnique d'Abomey-Calavi. p. 92

Albuquerque UP, Paiva RF (2004). M´etodos e t´ecnicas na pesquisa etnobotˆanica. Recife: Editora Livro R´apido/NUPEEA.

Arbonnier M (2002). Arbres, arbustes et lianes des zones sèches d'Afrique de l'Ouest. CIRAD / MNHN p. 573.

Botha J, Witkowski ETF, Shackleton CM (2004). Market profiles and trade in medicinal plants in the Lowveld, South Africa. Environ. Conserv. 31(1): 38–46.

Blay D (2004). Dental hygiene and livelihoods: a case of chewing sticks in Ghana In Forest Products, Livelihoods and Conservation: Case study of Non-Timber Forest Products. Vol 2 Africa. pp. 25-36

Chaaib KF (2004). Investigation phytochimique d'une brosse à dents africaines *Zanthoxylum zanthoxyloides* (Lam.) Zepernick et Timler (Syn. *Fagara zanthoxyloides* L.) (Rutaceae) p. 211.
Djossou CV (1985). La brosse végétale : Moyen traditionnel d'hygiène bucco-dentaire des Africains p. 7.
da Matha-Sant'anna M (2001). Régime d'occupation des terres, statut des aires protégées, mode de gestion et d'aménagement, activités humaines et habitats humains. PAZH/Cotonou/Bénin, p.35
Emanuel PL, Shackleton CM, Baxter JS (2005). Modelling the sustainable harvest of *Sclerocarya birrea* subsp. caffra fruits in the South African lowed. For. Ecol. Manag. 214: 91–103.
FAO (2000). Agriculture – Towards 2015/30 Interim report. p. 88.
FAO (2001). Statistique sur les produits forestiers non ligneux dans la république Togolaise. p.120
Gaoue OG, Ticktin T (2007). Patterns of harvesting foliage and bark from the multipurpose tree *Khaya senegalensis* in Benin: Variation across ecological regions and its impacts on population structure. Biol. conserve. 37: 424 –436
Griffiths AD, Philips A, Godjuwa C (2003). Harvest of *Bombax ceiba* for Arboriginal arts industry, central Arnhem Land, Australia. Biol. Conserv. 113: 295–305.
Hamilton AC (2004). Medicinal plants, conservation and livelihoods. Biodivers. Conserv. 13(8): 1477–1517.
Houghton PJ, Raman A (1998). Réactifs spécifiques et réactions du criblage phytochimique. Laboratory handbook for the fractionation of natural extracts. Ed. Chapman and Hall first edition, New York p. 199.
INSAE (2002). Troisième Recensement Général de la population et de l'habitat ; Résultat partiels. Cotonou. Bénin pp. 15-25.
MacGregor AB (1963). Increasing caries incidence and changing diet in Ghana. Int. J. Den. Hyg. 3 : 516-522.
Maley J (1996). The African rain forest - main characteristics of changes in vegetation and climate from the Upper Cretaceous to the Quaternary. In: Alexander I.J., Swaine M.D. & Watling R. (eds.).
Martin C (1991). The rainforests of West Africa. Birkhauser Verlag Publishers. Basel. Switzerland p. 235
Neuwinger HD (1996). African Ethnobotany. Poisons and Drugs: Chemistry, Pharmacology, Toxicology. Chapman & Hall, London. p. 145
OMS (1974). Etude des ressources floristiques du nord entre Cayar et St Louis. Projet. Sénégal PIP. 01, 70 p + annexes.
PAFT (1987). Exploitation et utilisation des produits forestiers non ligneux en Afrique. Lomé. p. 5.
Peres CA, Baider C, Zuidema PA, Wadt LOH, Kainer KA, Gomes-Silva DAP, Salomao RP, Simoes LL, Franciosi ERN, Valverde FC, Gribel R, Shepard Jr, GH, Kanashiro M, Coventry P, Yu DW, Watkinson AR, Freckleton RP (2003). Demographic threats to the sustainability of Brazil nut exploitation. Sci. 302: 2112-2114.
Pousset JL (1989). Plantes médicinales africaines: Utilisations pratiques. Editions Ellipses, Paris pp. 81-83.
Sokpon N (1995). Recherches écologiques sur la forêt dense semi-décidue de Pobè au Sud-Est du Bénin : groupement végétaux, structure, régénération naturelle et chute de litière. Thèse de doctorat. ULB. p. 349.
Stewart KM (2003). The African cherry (*Prunus africana*): Canlessons be learned from an over-exploited medicinal tree? J. Ethnopharmacol. 89: 3-13.
Whitmore TC (1990). An introduction to tropical rain forests. Clarendon Press, Oxford. p. 225.