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RESEARCH ARTICLE

**ETHNOBOTANICAL STUDIES OF MEDICINAL PLANTS USED IN THE TREATMENT OF STROKE
SEQUELAE IN THE DISTRICT OF ABIDJAN, CÔTE D'IVOIRE.**

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Abstract

Stroke is a public health emergency. This study was carried out in the markets of the District of Abidjan, from April to June 2018, to evaluate the knowledge of Traditional Medicine Practitioners on stroke related to its risk factors, sequelae and phytotherapeutic tools used for treatments. Based on semi-direct interviews, 306 herbalists were interviewed. The results showed that hypertension (Fc = 100%) is the major risk factor known by practitioners. Hemiplegia (95.5%), aphasia (80.1%), slurred speech (66.2%) and vision (48.1%) were the main sequelae. A total number of 101 medicinal plants, distributed in 93 genera and 49 families are sold on markets. *Ficus mucoso* (0.19%), *Ziziphus jujuba* (0.13%), *Ocimum gratissimum* (0.08%), *Parkia biglobosa* (0.08%), *Catharanthus roseus* (0.07%) are the most mentioned species. The calculation of the ICF yielded an average consensus at the plant level used to treat hemiplegia, aphasia and slurred speech. This exploratory study should play a role in the management of patients and development traditional medicines.

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Introduction:-

Stroke is defined by the World Health Organization (WHO) as the rapid development of localized or global signs of cerebral dysfunction with symptoms lasting more than 24 hours that may lead to death, with no apparent cause other than vascular origin (WHO, 2005; Rusinaru, 2010). Strokes are groups of conditions in which infarction or ischemic stroke is distinguished from cerebral hemorrhage or hemorrhagic stroke. The infarction is caused by an obstruction of intra-cranial blood vessels while the cerebral hemorrhages are owed to a break of vessel. In all cases, this results in a lack of oxygen and nutrients that jeopardize the functioning of the brain areas concerned. The main risk factors are smoking, high blood pressure, physical inactivity, unhealthy diet, obesity, diabetes, high blood lipids, irrational alcohol consumption, aging, low level of education as well as genetic and psychological factors (WHO, 2006). Sequelae due to stroke represent a vast pathological group, ranging from hemiplegia to slurred speech (aphasia), vision, hearing, or behaviour (Hendricks et al., 2002). Regardless to aetiologies, Stroke, is the leading cause of disability in adults (Rusinaru, 2010) and death in the world, in the category of cardiovascular disease, after coronary heart disease, with 6.2 million deaths (Mendis et al., 2011). These authors estimate that one person has a stroke every 5 seconds worldwide. WHO is talking about pandemic and progressive increase in incidence worldwide from 16 million cases in 2005 to nearly 23 million in 2030 (Masters and Loncar, 2006). In addition, during the last 20

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years, the stroke mortality rate has increased in low and middle-income countries. In these countries, 80% of death occur are due to stroke (Sagui et al., 2007). In Côte d'Ivoire, 9.3% of death in public hospitals among people aged from 45 to 69 are due to stroke (Cowppli-Bony et al., 2007). The hospital prevalence is estimated at 28% and the prognosis in hospitalization is based on a morbidity of about 24% (Diarra et al., 2016). Stroke mortality remains high during months following the accident, with approximately 25 to 30% of death occurring after one month, and 40 to 50% after six months (Rusinaru, 2010). Motor recuperations are incomplete for 2/3 of people, and human assistance is essential for 25 to 30% of them (Hendricks et al., 2002). The severity of this pathology is probably related to the inadequacies of management. Stroke is therefore a public health emergency. This disease will pose in the incoming decades the problem of the care of a growing number of patients and disabled people, demanding a large amount of human, material and financial resources (Sautereau, 2009). For providing suggestions for a pathology that we still do not really know how to treat clinically (Bouleti et al., 2014), it is necessary to look for other therapeutic arsenals. The aim of this study was to assess Traditional Practitioners' knowledge of stroke, its risk factors and its sequelae, and medicinal plants used in the treatment of brain damage induced sequelae in the District of Abidjan.

Study Area:-

The District of Abidjan is the economic capital of Côte d'Ivoire, located Southern Côte d'Ivoire between at 5°20'27" N latitude and 4° 01'41" W longitude (Figure 1). The population of the District that represents 20.8 % of the demographic weight of Côte d'Ivoire is 4,707,404 of the 22,671,331 inhabitants living in the country (RGPH, 2014).

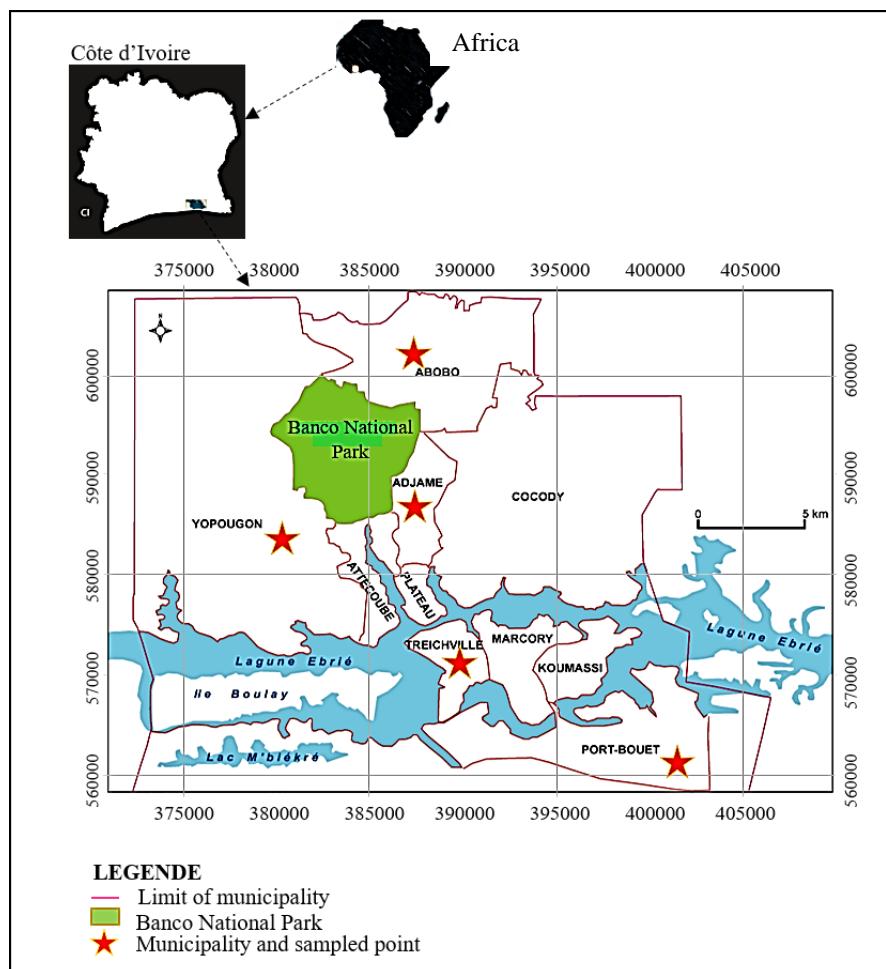


Figure 1:-Location map of Abidjan District

The population is heterogeneous and very cosmopolitan. In this city almost all the ethnic groups living in Côte d'Ivoire, are represented. Moreover, various populations coming from West African sub-region are living in Abidjan. Four university health centres are located in Abidjan and these facilities are preferential destination in case of a medical emergency (Konan, 2012). Traditional health Practitioners are also well represented (Manouan et al., 2010) and play an important role in the health care system. The study was conducted in four municipalities of the city of Abidjan (Adjame, Abobo, Yopougon and Port-Bouët). These municipalities were selected due to their density of populations, the presence within them of great markets of medicinal plants and their location. Abobo, Yopougon and Port-Bouët are gateways to the district, while Adjame in the centre has the largest wholesale market of medicinal plants.

Methods:-

Ethnobotanical surveys

Ethnobotanical investigations were conducted from April to June 2018, in seven markets of the District: Siaka Koné and Abobo II markets in Abobo; the large medicinal plant market of Adjame; markets of Sicogi and Wassakara in Yopougon; and the major markets of Treichville and Port-Bouët. The surveys were conducted on the basis of a questionnaire during a semi-directive interview with herbalists. The herbalists surveyed were randomly selected based on their ability to collaborate and share their knowledge. The items in the survey card included information on the respondent's identity, his knowledge of stroke, and the use of medicinal plants to treat the sequelae of brain damage.

Identifications of medicinal species

Numerous plant samples were purchased during the interviews for identification, but also for encouraging the seller to collaborate and to provide more information. The plant samples were identified, named using the flora of Arbonnier (2000) and Aké-Assi (2001 and 2002), then updated with APG IV on the online database of Conservatory and Botanical Garden of the city of Geneva. The list medicinal of species has been cross-checked with that of IUCN (www.iucnredlist.org) for the identification of species with special status.

Data processing

The studied population was characterized from the variables studied (gender, age, ethnicity, level of education and years of experience) and their knowledge of risk factors and stroke sequelae. The Relative frequency of citation (RFC) of each plant sold by herbalists was calculated according to the formula:

$$\text{RFC} = \frac{\text{Number of citations}}{\text{Number of herbalists}}$$

The Informant Consensus Factor (ICF), was used to assess the degree of consensus in treating stroke-related sequelae. It is calculated according to the formula of Heinrich et al. (1998):

$$\text{ICF} = \frac{\text{Nur} - \text{Nt}}{\text{Nur} - 1}$$

Where Nur refers to the number of citations of a given sequel and Nt the total number of plants used. The ICF varies between 0 and 1. A low value indicates that informants disagree about the use of plants in therapy.

Results:-

Sociodemographic characteristics of the respondents:-

A total number of 306 herbalists were interviewed on the therapeutic use of medicinal plants marketed in the District of Abidjan for the treatment of the post stroke. Most of the herbalists were women. The age of herbalists varied from 20 to 65 years old with a high frequency between 40 and 50 years (Table 1). The Mandés of North (35.4%), the Gours (24.01%), foreigners (19.7%) and Akans (18.5%) were the most numerous. The other ethnic groups represented only 1.5% of the herbalists. These practitioners were mostly illiterate (61.8% of the population surveyed), against 29% with a primary level and 6% a level of secondary education (Table 1). More than half of the herbalists had more than 10 years of practicing experience in the field of herbal medicine: 32% between 10 and 20 years, 19% between 20 and 30 years and 4% more than 30 years of experience. The highest percentage of herbalists interviewed was observed in the municipality of Abobo (42%).

Table I:-Socio-demographic characteristics of the herbalists surveyed (n = 306)

	Characteristics	Frequencies (%)
Gender	Women	99.3
	Men	0.7
Age groups	[20 - 30[	14.6
	[30 - 40[	31.1
	[40 - 50[	47.6
	[50 - 60[	3.9
	[60 - 70[	2.8
Ethnic group	Akan	18.5
	Gour	24.0
	Mandé of North	35.4
	Mandé of South	1.20
	Krou	0.30
	Foreign	19.7
Level of study	Illiterate	61.2
	Primary	29.3
	Secondary	5.8
	Superior	0
	Koranic	3.7
Years of experience	]0 - 10]	45.5
	]10 - 20]	31.8
	]20 - 30]	18.7
	]30 - 40]	2.3
	]40 - 50]	1.7

Stroke Knowledge:-

In the markets surveyed, 17.32% of the herbalists did not know stroke. The majority of practitioners (88.68%) recognized stroke, but no herbalist interviewed differentiates ischemic stroke from haemorrhagic stroke. All recognized a single of stroke. They attributed primarily to severe hypertension with 100% relative frequency of citation (Figure 2). For herbalists, stroke is directly related to hypertension. Malinkés attributed to this disease the name of "tension bana" when others simply call it "tension". There was no local name for this vascular accident. Other known risk factors are obesity, cited by 22.8% of respondents, diet associated to lifestyle (21.6%), and stress (19.8%). For 14.4%, the origin of this disease could be mystical and caused by witchcraft. Respondents also mentioned diabetes, chronic headache and fatigue. Hemiplegia was the main sequelae cited by 95.5% of the respondents (Figure 2). Other known sequelae were aphasia of the herbalists (80.1%), speech disorder (66.2%), vision disorders (48.1%) and behavioural disorders (25.9%). Other sequelae such as chronic headache, earache and sinusitis were very weakly cited.

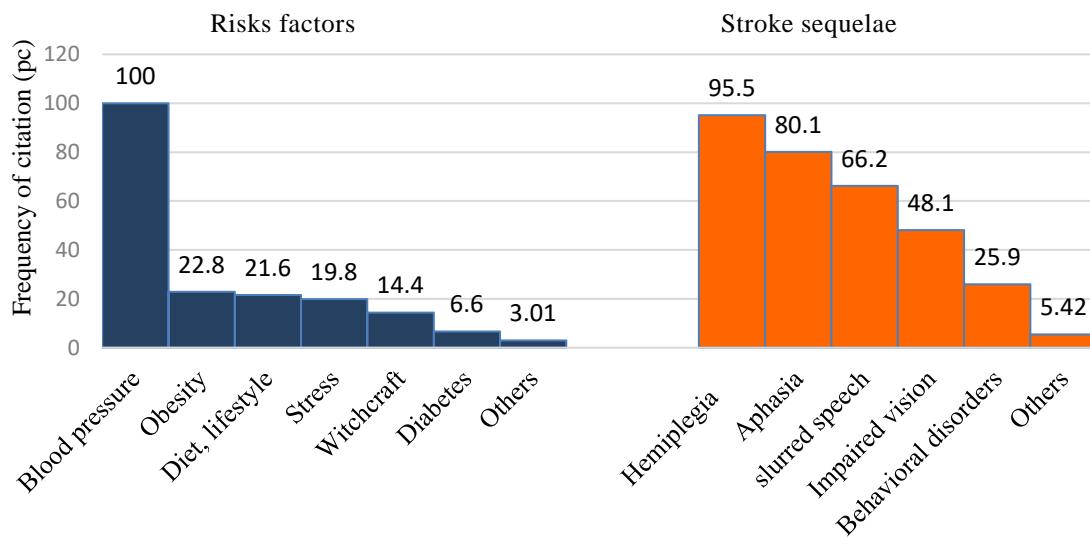


Figure 2:-Relative frequency of citation of risk factors and sequelae of stroke

Species richness and composition of the medicinal flora involved in the treatment of stroke sequelae:-

A total of 101 species belonging to 93 genera and 49 families was identified to be used in the treatment of the post-effects of stroke in the markets of the District of Abidjan. Fabaceae (16 species) were the most dominant families, followed by the Combretaceae (6 species), Asteraceae, Euphorbiaceae and Moraceae (5 species each), (Table 2). Most medicinal plants identified were trees (75.8%), followed by herbaceous plants (20%) and lianas (4.2%). In the present study, microphanerophytes were the most represented (51%), followed by nanophanerophytes (19%) and mesophanerophytes (14%). The plants cited come from different biogeographical area (Figure 3). The common origin was Sudano-Zambezian and Guinean-Congolese transition zone (44%), follow by Sudano-Zambezian region (26%). Exotic or cultivated species are also marketed by herbalists (Figure 3). Quoting frequencies were low and range from 0.19 to 0.004. The Relative frequency of citation was calculated for *Ficus mucoso* illustrated on figure 4a and *Ziziphus jujuba* (0.19 each), followed by *Ocimum Gratissimum* (0.13), *Parkia biglobosa* (0.08), *Catharanthus roseus* (0.08; Figure 4c), *Tamarindus indica* (0.07), *Annona muricata* (0.06), *Boscia senegalensis* (0.06; Figure 4b), *Acacia macrostachya* (0.05), *Khaya senegalensis* (0.05). Among the most important species cited during this study, *Annona muricata* was the only introduced species. *Khaya senegalensis* and *Vitellaria paradoxa* was vulnerable species, while *Isoberlinia doka* had a low risk of extinction.

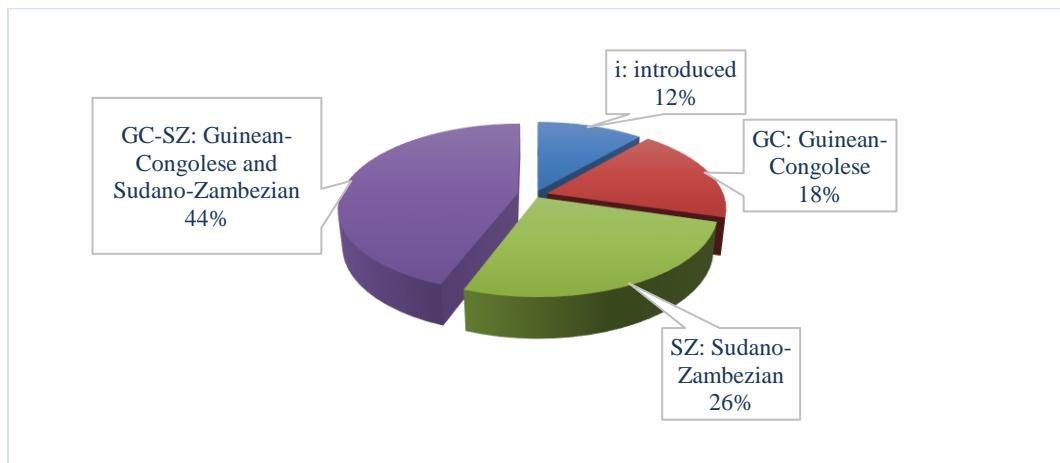


Figure 3:-Phytogeographic distribution of species used to treat stroke sequelae

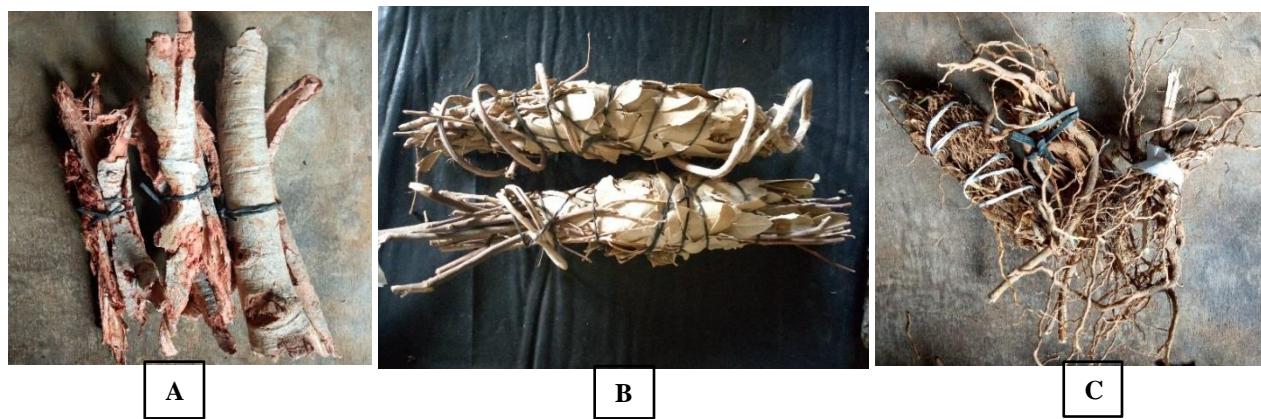


Figure 4:-View of bark of *Ficus Mucoso* (A), leaves of *Boscia senegalensis* (B) and roots *Catharanthus roseus* (C)

Table II:-General characteristics of commonly cited species to treat stroke sequelae

Mor. : morphology, a: tree, h: grass, al: creeping tree, **GC**: Taxon of the Guineo-Congolese region (dense humid forest), **GC-SZ**: Taxon of the transition zone between the Guineo-Congolese region and the region Sudano-Zambezian, **GCW**: Taxon endemic to the forest block in western Togo, including Ghana, Côte d'Ivoire, Liberia, Sierra Leone, Guinea, Guinea Bissau, Gambia and Senegal, **i**: Taxon introduced or cultivated. **H**: hemiplegia, **Te**: speech disorder, **Tv**: vision disorders, **A**: aphasia, **Ha**: hypotensive, **F**: tiredness, **Tc**: behavioral disorder.

RFC	Plant species	Local names or vernacular names	Family	Bio-mor types & Chorol.	Used parts	Modes of preparation	Modes of use	Sequelaes treated
0.19	<i>Ficus mucoso</i> Ficalho	Gonan (Malinké); N'Gounan (Baoulé)	Moraceae	amP; GC	Bark	Decoction	Drink, Massage, Bath and Mouthwash	H, Te, Tv, A, Ha
0.13	<i>Ziziphus jujuba</i> Mill.	Tômonnon (Malinké)	Rhamnaceae	Anp	Leaves, Whole plant	Decoction	Drink, Massage, Bath, Mouthwash, Enema	H, Te, Tv, A, Ha
0.08	<i>Ocimum gratissimum</i> L.	Amangnrin (Baoulé)	Lamiaceae	Hnp; GC-SZ	Leaves, Whole plant	Decoction, Trituration	Drink, Massage, Bath, Mouthwash and eyes	H, Te, Tv, A, Fa
0.08	<i>Parkia biglobosa</i> (Jacq.) Benth.	Néré (Malinké); Kpalé (Baoulé)	Fabaceae	amp; SZ	Bark, Leaves	Decoction	Drink, Massage, Bath	H, A, Ha
0.07	<i>Catharanthus roseus</i> (L.) G.Don	Pervenche de Madagascar or Nivaquine	Apocynaceae	Hnp; GC	Root, Stem, Whole plant, Leaves	Decoction	Drink, Massage, Bath	H, Te, Tv, Ha
0.07	<i>Tamarindus indica</i> L.	Tamanrin or Tomi (Malinké)	Fabaceae	Amp; GC-SZ	Bark, Stem, Leaves	Decoction	Drink, Massage, Bath	H, Te, Tv, Ha

0.06	<i>Annona muricata</i> L.	Amlonodou (Baoulé)	Annonaceae	Amp; I	Leaves, Root	Decoction	Drink, Massage, Bath	H, A, Ha
0.06	<i>Boscia senegalensis</i> Lam.	Béré (Malinké)	Capparaceae		Leaves, Stem	Decoction	Drink, Massage, Bath	H, Te, Tv, A, Ha
0.05	<i>Acacia macrostachya</i> DC.	Kikiri (Malinké)	Fabaceae	Amp; GC-SZ	Leaves, Stem	Decoction	Drink, Massage, Bath	H, Tv, A
0.05	<i>Khaya senegalensis</i> (Desr.) A. Juss.	Djala (malinké)	Meliaceae	amp; SZ	Bark, Leaves Root	Decoction	Drink, Massage, Bath, Mouthwash	H, A
0.04	<i>Phyllanthus amarus</i> Schumach. & Thonn.	Milles maladies	Phyllanthaceae	anp; GC	Whole plant	Decoction	Drink	H, Te, Tv, Ha
0.04	<i>Tectona grandis</i> L.f.	Teck	Lamiaceae	aMP; I	Leaves	Decoction	Drink, Massage, Bath	H, A
0.04	<i>Uapaca togoensis</i> Pax	Sômon (Malinké)	Euphorbiaceae	amP; GC-SZ	Bark, Leaves	Decoction, To crush	Drink, Massage, Bath, Enema	H, Te, Ha
0.04	<i>Guiera senegalensis</i> J.F.Gmel.	Koungbê (Malinké)	Combretaceae	amp; SZ	Leaves, Stem	Decoction	Drink, Massage, Bath	H, Te, Tv, A
0.04	<i>Piliostigma thonningii</i> (Shum.) Milne-Redh.	Gnaman (Malinké)	Fabaceae	amp; GC-SZ	Leaves	Decoction	Drink, Massage	H, A, Ha
0.04	<i>Vitellaria paradoxa</i> C.F.Gaetn	Chii (Malinké)	Sapotaceae	amp; SZ	Bark, Leaves, Fruit, Root	Decoction	Drink, Massage, Bath	H, A, Ha
0.04	<i>Cissus populnea</i> Guil & Perr.	Folocofalaca (Malinké)	Vitaceae	amp; GC-SZ	Leaves	Decoction, Trituration after fire	Drink, Massage	H
0.04	<i>Detarium senegalense</i> J.F.Gmel	Tabacoumba (Malinké)	Fabaceae	amP; GC-SZ	Leaves	Decoction	Drink, Massage, Bath, Mouthwash	H, A, Ha
0.04	<i>Jatropha curcas</i> L.	Bagani (Malinké); Aplôplô (Baoulé)	Euphorbiaceae	anp; I	Leaves	Decoction, Trituration after fire	Drink, Massage, Bath	H, Ha
0.04	<i>Pericopsis laxiflora</i> (Baker) Meeuwen	Kolokari (Malinké)	Fabaceae	amp; SZ	Leaves, Root	Decoction	Drink, Massage, Bath	H, Tv
0.04	<i>Salacia stuhlmanniana</i> Loes. (Cent nerf)	Fassakérnin (Malinké)	Celastraceae		Bark, Leaves, Stem, Root	Decoction, crush or burn + shea butter	Drink, Massage, Bath	H, A

0.03	<i>Annona senegalensis</i> Pers.	Mandésoussou (Malinké)	Annonaceae	anp; SZ	Leaves, Stem	Decoction	Drink, Bath	H, A
0.03	<i>Heliotropium indicum</i> L.	Chameleon tail; Lolowlêloï (Baoulé)	Boraginaceae	hTh; GC-SZ	Leaves	Trituration	Drink, Eye bath	H, Tv
0.03	<i>Palisota hirsuta</i> (Thunb.) K.Schum.	Sénzéro (Baoulé)	Commelinaceae	hnp; GC	Bark, Leaves	Decoction	Drink, Massage, Bath, Enema	H
0.03	<i>Persea americana</i> Mill.	Avocatier	Lauraceae	amp; I	Leaves	Decoction	Drink, Massage, Bath	H, Tv, Te, Ha
0.03	<i>Picralima nitida</i> (Stapf) T.Durand & H.Durand	Aboya; Boya (Baoulé)	Apocynaceae	amp; GC	Fruit	Decoction, Maceration	Drink	H, Ha
0.03	<i>Alchornea cordifolia</i> (Schumach. & Thonn.) Müll.Arg.	Djéka (Baoulé)	Euphorbiaceae	almp; GC-SZ	Bark	Decoction	Drink, Massage, Bath	H, Te, Tv, Ha
0.03	<i>Bridelia ferruginea</i> Benth.	Sagba (Malinké)	Phyllanthaceae	amp; GC-SZ	Bark, Leaves	Decoction	Drink, Massage, Bath	H, Te, Tv, A, Ha
0.03	<i>Cassia sieberiana</i> DC.	Gbin (Malinké)	Fabaceae	amp; GC-SZ	Bark, Leaves	Decoction	Drink, Massage, Bath	H, Tv, Ha
003	<i>Crossopteryx febrifuga</i> (G. Don.) Benth.	Kloklo (Malinké)	Rubiaceae	amp; GC-SZ	Leaves, Bark	Decoction	Drink, Massage, Bath	H, Tv, A
0.02	<i>Annickia polycarpa</i> (DC.) Setten & Maas ex I.M.Turner	Korfhi, Jaune (Malinké)	Annonaceae	amP; GC	Bark	Decoction	Drink, Massage, Bath	H, Ha, Fa
0.02	<i>Cymbopogon citratus</i> (DC.) Stapf	Citronnelle	Poaceae	hH; GC-SZ	Leaves	Decoction	Drink	H, Tv, Tc, Ha
0.02	<i>Newbouldia laevis</i> (P. Beauv.) Seem. ex Bureau	Isope; Tonzoué (Baoulé)	Bignoniaceae	amp; GC	Leaves	Decoction	Drink, Enema	H
0.02	<i>Syzygium guineense</i> (Willd.) DC. Subsp. <i>Guineense</i>	Kissan (Malinké)	Myrtaceae	amp; SZ	Leaves	Decoction	Drink, Massage, Bath and Mouthwash	H, A, Fa
0.02	<i>Terminalia catappa</i> L.	Côcôman	Combretaceae	amP; I	Leaves	Decoction	Drink	H

General characteristics of medicinal plants used:-

Parts used, methods of preparation and administration

The common plant parts were leaves (55.9%), barks (22.3%) and stems (11.2%), followed by Roots (6%) and fruits (4%). For *Ziziphus jujuba*, *Ocimum gratissimum*, *Catharanthus roseus*, *Phyllanthus amarus*, *Ageratum conyzoides* and *Paullinia pinnata*, the whole plant was also used in preparations. The pharmacological preparation was mostly decoction with 85.9% of frequency of citations, compared to 14.1% for all other methods of preparation (Trituration, kneading, calcination and maceration) (Figure 5). The decocted and all preparations are generally absorbed by oral route in 86.1%, skin absorption by body massage (66.33%) and skin absorption by bath (55.44%). The massage was done with a piece of cloth, a towel or a floor cloth. Other modes of absorption, mouthwash, enema, facial rinsing, etc. were less common (Figure 6). Plants counted in 223 medicinal recipes, of which 18.9% were composed of monospecific recipes and 81.1% of multispecies recipes. The multispecies recipes containing three species were the most numerous, 40.2% of the preparations, against 30.1% of the bi-specific preparations and 14.5% of the tetra-specific preparations. Few multi-species preparations containing more than four species were prescribed (0.9%).

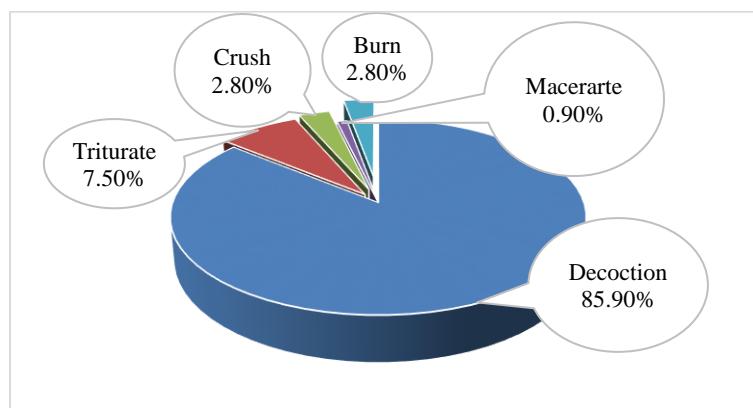


Figure 5:-Methods of preparation of medicinal plants

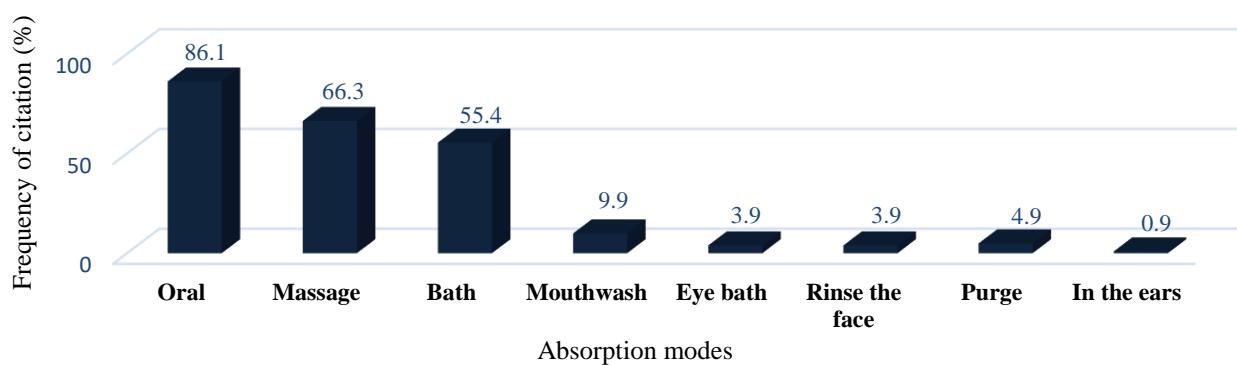


Figure 6:-Absorption of drug preparations

Characteristics of the treatments for the different known sequelae of stroke

The various sequelae of stroke were treated by many plant drugs from several plant species. The most commonly treated sequel was Hemiplegia with 92 medicinal species, 37 species for Aphasia, 25 for vision disorders and 15 for speech disorders. Only four species were mentioned for fatigue and three for behavioural disorders. Hypertension was treated by 31 species as sequelae of stroke. For herbalists, the increase in blood pressure was directly associated with stroke as a direct cause and then as disorders to treatment. Regulating the blood pressure would greatly help to heal the stroke to which it was very often assimilated. The most cited species for regulating blood pressure were *Catharanthus roseus* and *Annona muricata*. In the case of hemiplegia, disorders of vision and aphasia, *Ficus mucoso*, *Ziziphus jujuba* and *Ocimum gratissimum* were frequently cited. Most of the time, the remedy was used until the complete disappearance of the sequelae or during at least a month. The calculation of the degree of consensus showed that the ICF varies from 0.25 to 0.63. An average consensus was observed at the plant level used for hemiplegia (0.63), aphasia and slurred speech (0.51). Treatment of other sequelae (vision disorder, behavioural disorder and hypertension) was not a consensus among herbalists. The ICFs (0.42, 0.38 and 0.25) were less than the average value of 0.5.

Table III:-Floristic Richness and Consensus in Treatment of Stroke Outbreaks

Known sequelae	Number of species used	ICF	Frequent species
Hemiplegia	92	0.63	
Aphasia	37	0.51	
Vision disorder	25	0.42	
Speech disorder	15	0.51	
Hypertension	31	0.42	<i>Catharanthus roseus</i> , <i>Phyllanthus amarus</i> , <i>Parkia biglobosa</i>
Behaviour disorder	3	0.38	<i>Cymbopogon citratus</i> , <i>Pseudocedrela kotschy</i>
Tiredness	4	0.25	<i>Annickia polycarpa</i> , <i>Opilia amentacea</i>

Discussion:-

The purpose of this study was to determine traditional practitioners' knowledge of stroke risk factors, sequelae, and to identify plants used for their treatment. The investigations were carried out with 306 herbalists. The results showed that the sale of medicinal plants in the markets of the District of Abidjan is led by women over 40 years old, illiterate for the majority as mentioned by Ambé et al. (2015). The people of the central and northern regions of Côte d'Ivoire constituted most herbalists. This may be explained by socio-cultural habits. Gours and Malinkés are traders from generation to generation (Konaté, 2016). The Akans are known for their great knowledge of plants and their uses in pharmacopoeia (Manouan et al., 2010). This ethnic group is regularly cited in ethnobotanical studies (Piba et al., 2011, Ambé et al., 2015).

The assessment of knowledge about stroke, its risk factors and sequelae, shows that the brain damage are not known and treated by all practitioners. No questioned practitioner makes the difference between haemorrhagic stroke and ischemic stroke. The character of the emergence of this disease could justify these results. According to Diarra et al. (2016), stroke-dominated vascular disease supplants infectious pathology in Tropical area for only a few years. The increase in the incidence and prevalence of this disease is relatively recent (Feigin et al., 2014). The means of diagnosis of the type of stroke are also limited. In modern medicine, only brain image allows an adequate diagnosis (Sagui et al., 2007) and appropriate treatment. The interpretation of the results shows that for herbalists, high blood pressure is the leading cause of stroke by far. Numerous recent clinical studies in Côte d'Ivoire (N'Goran et al., 2015, Diarra et al., 2016), and Africa (Sagui, 2007, Coulibaly et al., 2010, Chraa and Kissani, 2015) cited hypertension as the leading cause of stroke and confirms this result. Arterial hypertension is on the rise worldwide. In Côte d'Ivoire, the most recent data from WHO (2018) showed a prevalence of 22%. Hypertension is the major risk factor, however other equally important factors such as alcoholism and diabetes accounted for 27% (Diarra et al., 2016) and 11% (N'Goran et al., 2015), respectively causes of stroke in Côte d'Ivoire are less cited. According to WHO data (2006), the risk of stroke also increases with age due to the weakening of the arterial wall. Other less dominant etiological circumstances are unknown. It is heredity and specific diseases such as hypercholesterolemia, atrial fibrillation, blood clotting disorders (Rusinaru, 2010). The main sequelae mentioned in this study agree with conventional

medicine, which cites hemiplegia, aphasia, slurred speech and vision as major sequelae (Hendricks et al., 2002) and confirms the accurate knowledge of herbalists.

A total number of 101 species are sold to treat the post-effects of stroke in the markets. The study confirms the traditional use of medicinal plants for treating after-effects of stroke by Ivorian populations. The high number of species reflects the diversity of plants related the treatment of this pathology and indicates the importance of knowledge acquired in the treatment of sequelae by herbalist. Similar ethnobotany studies have shown a less rich flora of species used in the treatment of various pathologies. Koulibaly et al. (2016) have identified 28 species in the Daloa region in western Côte d'Ivoire. Tra Bi et al. (2008) and Ambé et al. (2015), inventoried respectively 58 and 63 species in the District of Abidjan. In Cameroon, Ladoh-Yemeda et al. (2016) quoted 84 species sold on the markets of Douala in Cameroon. The resulting flora is therefore a valuable source of information and enrich previous works. Among the species listed, those of the Fabaceae family are the most numerous. This could be explained by the new nomenclature adopted by APG IV which merges within this family those of Minosaceae and Caesalpiniaceae. Moreover, according to the work of Adomou et al. (2012), Caesalpiniaceae are among the richest botanical families used as medicinal plants. At the level of the phytogeographic distribution, the Guineo-Congolese and Sudano-Zambezian species, and are the most important. The distribution of the plants used is probably due to the geographical origin of most of the herbalists who come from the north-central area of Côte d'Ivoire characterized by the Sudanese domain. For Konan (2010), knowledge of the uses of medicinal plants and their properties are commonly acquired and transmitted from one generation to another. In addition, species from the Guineo-Congolese and Sudano-Zambezian transition zone are regularly used in herbal medicine by Ivorian practitioners (Koné et al., 2004, Dro et al., 2013). After the statistical analysis, it appears that the most cited species in the treatment of the post-effects of stroke have recognized therapeutic virtues. *Ficus mucoso* is used in the treatment of gynaecological obstetric disorders (N'Guessan et al., 2009). Akhter et al. (2013) and Chen et al. (2014) mentioned the chemical and phytotherapeutic properties of *Ziziphus jujuba* fruits. The low frequencies of citation could be explained by the diversity of species used in the treatment of the different sequels of stroke. The therapies offered by herbalists are diversified. More than 200 recipes have been enumerated. Multi-species preparations are the most cited. According to the herbalists, the combination of several plants may enhance the therapeutic power of the preparation. A recipe analysis revealed the predominance of leaves. The accessibility of this part of the plant could justify its important use. For absorption modes of preparations, besides oral administration of decoctions and baths that are common in Africa, body massage seems to be very important for the healing of hemiplegic or aphasic patients. It would stimulate the nerves, the muscles and arouse the motor sensitivity of the inert parts in the case of hemiplegia or deformed in the case of aphasia, especially since stroke causes almost 100% of motor deficit in Ivorian patients (N'Goran et al., 2015, Diarra et al., 2016). Hemiplegia is also very debilitating and represents a negative handicap for the socio-occupational future of this active segment of the population given the difficulties of rehabilitation in our countries (Diarra et al., 2016). It is therefore the best-known sequelae, the most treated by traditional medicine and presents a greater number of medicinal remedy sold on the markets. The calculation of the ICF showed an average consensus for the species mentioned for hemiplegia, aphasia and slurred speech. This is less the case for behavioural vision disorders and high blood pressure. However, 11 species used to treat hypertension, including *Catharanthus roseus*, *Phyllanthus amarus* and *Parkia biglobosa*, are also cited by Tra Bi et al. (2008). The multiplicity of species, recipes and therapeutic practices would be at the origin of the differences. In the case of the most frequently treated sequelae, the practical experience of the traditional healers and the comments of the customers would favour the consensus around the most effective species.

Three species listed in this study, *Khaya senegalensis*, *Vitellaria paradoxa* and *Isoberlinia doka*, have a special status and should be given attention when harvested as plant drugs. The exploitation and sustainable management of these medicinal plants are imperative to protect highly vulnerable species and biological diversity in general.

Conclusion:-

The present work was carried out for the first time, in Côte d'Ivoire, to evaluate the knowledge of practitioners of traditional medicine on cerebrovascular accident, its risk factors, sequelae and the phytotherapeutic means used for treatment. It reveals the knowledge of herbalists and shows that Ivorian flora is rich in medicinal plants used to treat after-effects of stroke. According to herbalist, high blood pressure is defined as the main risk factor while hemiplegia is the main known sequel. Among the variety of commercialized plants, *Ficus mucoso*, *Ziziphus jujuba*, *Ocimum gratissimum*, *Parkia biglobosa*, *Catharanthus roseus*, *Tamarindus indica*, *Annona muricata* and *Boscia senegalensis* are the commonly mentioned plants in medicinal preparations. Some species with special status based

on UICN list has been identified and should be protected. This work is an exploratory study conducted to provide data for future research in the perspective of improving the use as traditional plant-based medicines against the after-effects of stroke.

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