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Ethnopharmacological investigation of medicinal plants used to treat typhoid fever in Benin

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Abstract

Typhoid and paratyphoid fevers are serious infectious diseases caused by enterobacteria of the genus *Salmonella* that become resistant to existing antibiotics. As part of the valorization of medicinal plants used in the treatment of typhoid fever in Benin, an ethnopharmacological investigation was conducted among 109 traditional healers, 151 herbalists and 130 elderly people in thirteen communes targeted in the departments of southern Benin.

At the end of the investigation, 109 plant species belonging to 100 genera and 52 families were identified. These inventoried plant species are used in 235 recipes. Leaves (68%) are the most used plant organs in the form of decoctions (91%) and are administered orally (99,74%). The fruits of *Citrus aurantifolia* (31,79%) are the most used in these recipes, followed by leaves of *Corchorus olitorius* (23,85%), *Senna siamea* (20,51%) and roots of *Zanthoxylum zanthoxyloides* (16,1%). This study provides a database for further anti-typhoid drug formulation studies.

Keywords: investigation, medicinal plant, typhoid fever, herbalists, traditional healers, antibiotic

Introduction

Typhoid and paratyphoid fevers are life-threatening bacterial infections. The causative bacteria belong to the genus *Salmonella* enterica serotype Typhi or Paratyphi (A, B or C). Patients are usually infected by ingesting water and / or food contaminated with stool from infected persons or through direct person-to-person transmission. Acute illness is characterized by prolonged fever, headache, fatigue, and digestive signs (nausea, constipation or diarrhea). There are more serious forms with intestinal, cardiac or neurological complications that can be fatal without treatment.

Each year, typhoid affects between 11 and 20 million people and causes 128 000 to 161000 deaths^[1]. Typhoid fever is still in developing countries (Asia, Africa and Latin America), where it remains a significant public health problem. As in African countries, access to drinking water and primary health care in Benin is precarious and the incidence of typhoid fever is high^[2,3].

The antibiotic resistance of *Salmonella* Typhi is an emerging and important issue^[4-6].

New avenues are therefore to be explored for the development of new antibiotics capable of eradicating *Salmonella*.

According to WHO reports, more than 80% of people in developing countries use traditional medicine almost exclusively for treatment^[7]. Various ethnobotanical research work has been undertaken in Benin to document and thus perpetuate traditional medical knowledge. These include the work of Adjanohoun *et al.*^[8], Tossou^[9], Adomou *et al.*^[10], Fah *et al.*^[11] and Quiroz *et al.*^[12]. However, none of this work was concerned with plants specifically used for typhoid fever. This justifies the present study, which consists of collecting information on medicinal plants used by the elderly, marketed and offered by herbalists and traditional healers for the treatment of typhoid fever in southern Benin. This work consisted in identifying the plants traditionally used to treat typhoid fever in Benin.

Material and Method

Study area

The ethnopharmacological investigation was conducted in southern Benin between 6°25' N and 7°30' N and covering an area of 17109 km². The climate is subequatorial, characterized by a bimodal rainfall regime with two rainy seasons alternated by two dry seasons. The average annual temperature is 28°C, and the humidity varies between 69% and 97%^[13].

The most dominant soils are ferralitic soils on clay sediments, hydromorphic soils in valleys, lowlands and alluvial plains, vertisols in the Lama depression and tropical eutrophic brown

soils [14]. Phytogeographically, southern Benin is subdivided into four phytogeographic districts: Coastal, Pobè, Ouémé Valley and Plateau [15]. It belongs to the Guineo-Congolese zone which includes a mosaic of islands of dense rainforest, savannah, grassland, mangrove and fallow land. According to the same author, there were 1170 plant species recorded. Its population is 5369774 with a density that ranges from 100 inhabitants/km² in general to 322 inhabitants/km² in the Atlantic. The dominant ethnic groups are Fon and related (39.2%), Adja and related (15.2%) and Yoruba and related (14.5%) [16]. The dominant economic activities are trade and agriculture. Market gardening, livestock farming, fishing, crafts and tourism are also practiced.

Study method

Sampling technique of survey sites

The ethnopharmacological survey was conducted in the seven (07) departments of southern Benin, which represent the localities most affected by typhoid fever. Two communes have been chosen per department to cover the entire territory of the study area, a total of 13 towns (Figure 1) have been covered because the coastal department consists of a single municipality. The people surveyed are herbalists, traditional healers and the elderly.

The markets hosting the survey were selected based on previous work carried out in major markets that are full of large numbers of herbalists and Benin's market calendar [12]. Traditional healers were targeted from the directory of the Association of Traditional Practitioners of Benin (ANAPRABETAB) while the elderly were chosen at random. The sample size for the study was determined from the Dagnelie [17]. Formula:

$$n = \frac{Pi(1 - Pi)U_{1-\alpha/2}^2}{d^2}$$

Pi (80%) was determined from the WHO [7] report which showed that the proportion of people who use traditional medicine almost exclusively for treatment is about 80% in developing countries.

U_{1-α / 2} = 1.96, represents the value of the normal random variable for a risk α equal to 0.05. The expected margin of error d for any parameter to be estimated from the survey is 4%.

According to the calculation, the sample size is 384,16 ; this was rounded to 390 individuals whose distribution is shown in Table 1. The investigation was conducted in the period of January-March 2017.

Table 1: Survey locations, number of respondents by occupation and by location

Department	Town	N-Heb	N-Tra	N-PA	Total
Atlantique	Abomey-calavi	11	9	10	30
	Ouidah	10	10	10	30
Littorale	Cotonou	12	8	10	30
Ouémé	Dangbo	14	6	10	30
	Porto-Novo	11	9	10	30
Plateau	Sakété	12	8	10	30
	Kétou	10	10	10	30
Zou	Bohicon	10	10	10	30
	Zogbodoméy	12	8	10	30
Mono	Lokossa	11	9	10	30
	Comé	13	7	10	30
Couffo	Dogbo	11	9	10	30
	Kloué kanme	14	6	10	30
Total number		151	109	130	390

Légende: N-Heb: number of herbalists investigated ; N-Tra : number of traditional healers investigated ; N-PA : number of elderly people investigated

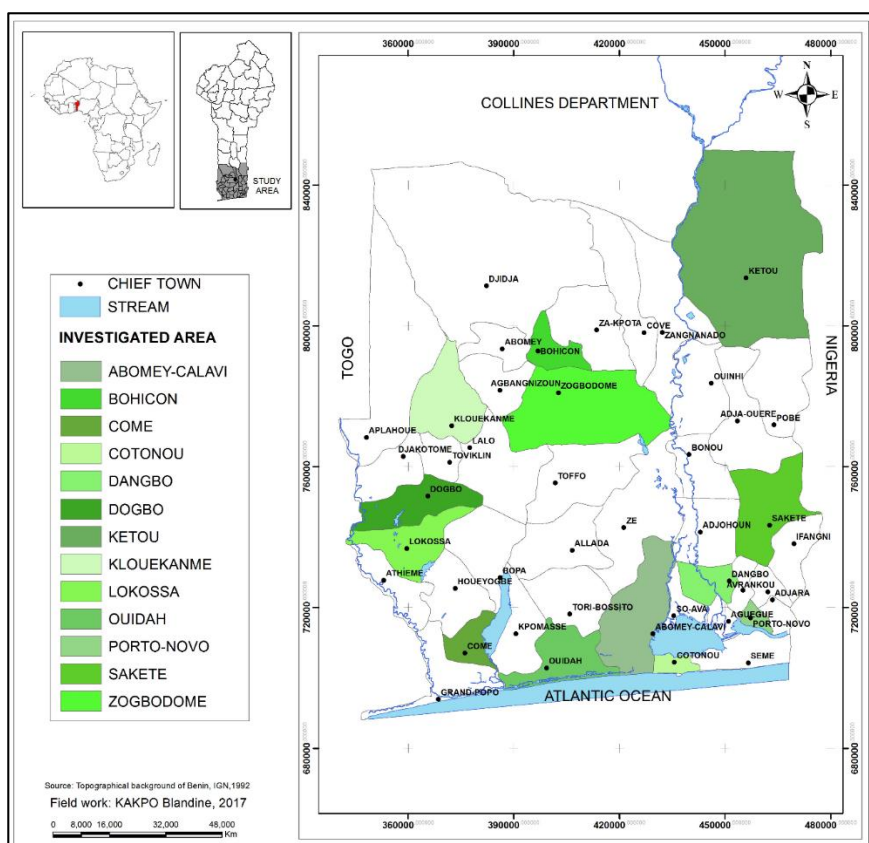


Fig 1: Location of the 13 towns of investigation

Survey technique

Ethnobotanical investigations were carried out among the various actors identified above. Thus, interviews were conducted with the respondents on the basis of a dialogue in local or French language.

For each respondent, the following information was collected: age, sex, ethnicity, marital status, social position and place of residence. The types of data collected for each plant cited relate to local names, parts used, methods of preparation, administration and collection locations. In addition, the way in which knowledge of medicinal plants was acquired by the respondent and the cost of treatment were recorded.

The plants mentioned are then bought from herbalists, specimens are collected from traditional healers and the elderly and sent to the National Herbarium of Benin. The taxonomic identification of medicinal plant species was made from Benin's analytical flora [18] and experts from the National Herbarium of Benin.

Method of data processing and analysis

The information recorded on the survey sheets was manually analyzed and recorded in a database designed and processed under the Excel 2013 spreadsheet. The matrix generated by this database made it possible to perform frequency analysis, sorting and graphs. It has been decided to determine the number of species used by the Beninese population in the treatment of typhoid fever, their vernacular and scientific names as well as their botanical families.

Relative frequency of citation (RFC)

The local importance of each species was calculated using the relative frequency of citation [19]. The calculation formula is as follows:

$$RFC = \frac{Fc}{N} * 100$$

Fc = number of investigated who mentioned the use of the species;

N = total number of investigated.

The proportion of species within the families (PF) of plants has been calculated by the following formula:

$$PF = \frac{E}{N} * 100$$

E = number of plant species belonging to the family ;

N = total number of species identified.

Results

Sociodemographic characteristics of the investigated

The study population consisted of 109 traditional healers (27.98%), 151 herbalists (38.72%) and 130 elderly people (33.33%). Of the 390 people surveyed, more than half of the respondents are women (Figure 2a).

About four in ten of those investigated are illiterate, only one-third have primary education and very few have a high school or university education (Figure 2b).

The maximum age of respondents is 77 years and the youngest surveyed at 29, the average age is 49 (Figure 3).

In the study area inhabited by eight ethnic groups, respondents of the Fon and Yorouba-Nago ethnic groups are the most numerous and represented by 34.1% and 23.8% respectively (Figure 4).

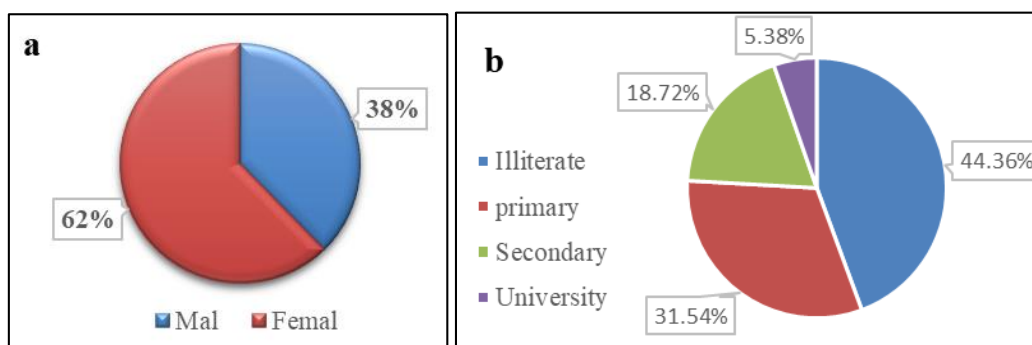


Fig 2: Distribution of survey profile according to (a) sex (b) academic level

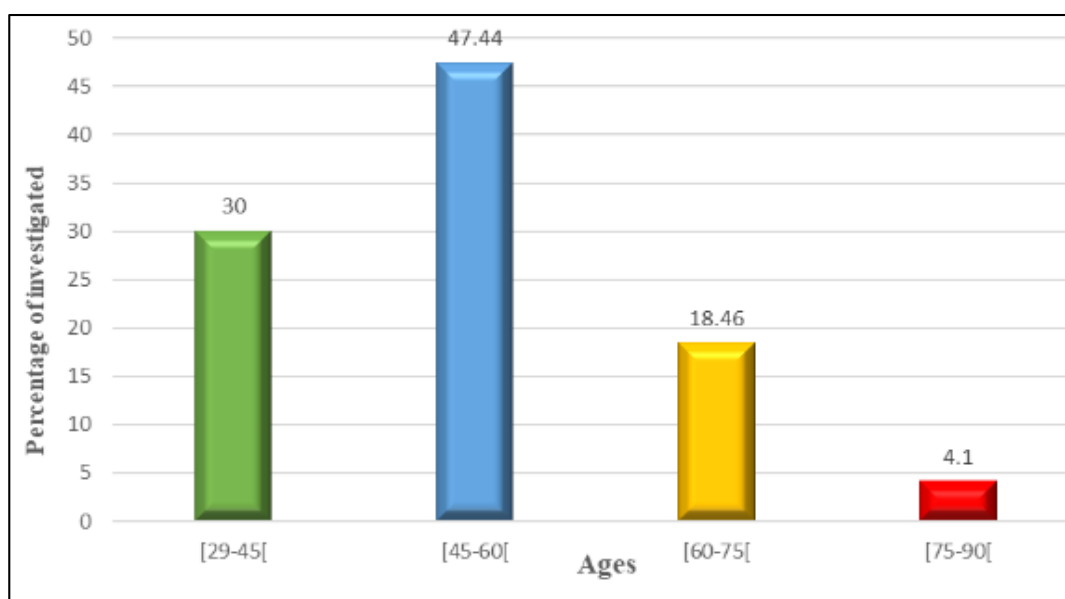


Fig 3: Percentage of investigated by age

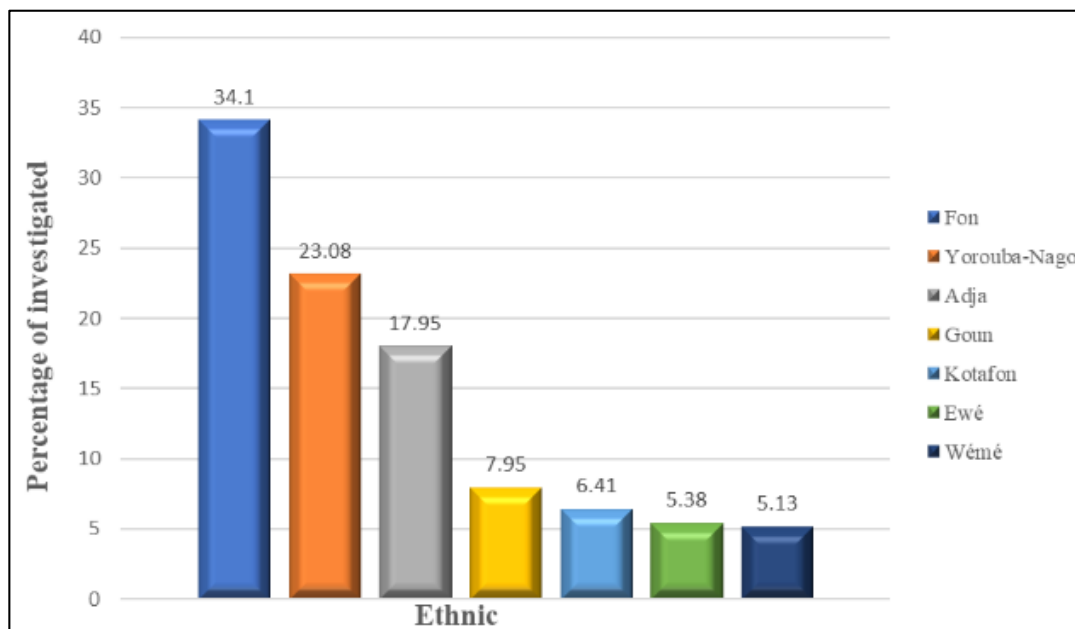


Fig 4 : Percentages of investigated by ethnicity

Ethnopharmacological data

The taxonomic diversity of recorded plants

The survey data identified 109 plant species belonging to 100 genera (Table 2) used to treat typhoid fever in Benin. Of the

109 species, at least 32 species have at least one citation frequency above 5%. Some anti-typhoid recipes listed include minerals such as: green clay, incense, white kaolin and potash.

Table 2: List of plants used in traditional medicine to treat typhoid fever in southern Benin

N°	Specie	Family	Vernacular name	Plant organ used	Type of use	Citation frequency (%)	MT
1	<i>Citrus aurantifolia</i> Syn.: <i>Limonia aurantifolia</i>	Rutaceae	klé (f) ; orombo were (y, n)	Fruit	Association	31,79	T
2	<i>Corchorus olitorius</i>	Tiliaceae	Nenounwi (f); Dun (y, n)	Plant	Association	23,85	H
3	<i>Senna siamea</i> Syn : <i>Cassia siamea</i>	Leguminosae- Caesalpinoideae	Kenu ma (f)	Leaf Bark Root Flower	Association	20,51	T
4	<i>Zanthoxylum zanthoxyloides</i> Syn.: <i>Fagara zanthoxyloide</i>	Rutaceae	Xè, xètin, (f); Ata ata hife (y, n)	Root	Association Only	16,41	T
5	<i>Sarcocephalus Latifolius</i> Syn.: <i>Nauclea latifolia</i>	Rubiaceae	ko (ma) (f); Egbèsi (y, n)	Root	Association	14,61	S
6	<i>Dichapetalum madagascariense</i> Syn.: <i>D. guineense</i>	Dichapetalaceae	Gbaglo, Gbonymisso (f, g)	Leaf	Association	13,08	S
7	<i>Ocimum gratissimum</i>	Lamiaceae	Tchao (f, g) ; Aribla (y, n)	Leaf	Association	11,02	H
8	<i>Cratava adansonii</i>	Capparaceae	Onton zunzen (f, g); tanyia, tamyia (y, n)	Leaf	Association	10,26	T
9	<i>Jatropha multifida</i>	Euphorbiaceae	Akpawi (f)	Leaf	Association	9,74	S
10	<i>Cymbopogon citratus</i>	Poaceae	Tcha (f) ; Tii oba (y, n);	Leaf	Association	9,74	H
11	<i>Khaya senegalensis</i> Syn.: <i>Swietenia senegalensis</i>	Meliaceae	Zunzatin (f) ; Oganwo, ago (y, n)	Root Bark Leaf	Association	9,74	T
12	<i>Momordica charantia</i> Syn.: <i>M. thollonii</i>	Cucurbitaceae	Nyensinken (f); Ejinrin (y, n)	Plant	Association	9,74	L
13	<i>Azadirachta indica</i>	Meliaceae	Kininutin (f, g); Dogon yaro (y, n)	Leafed stem	Association Only	9,23	T
14	<i>Combretum micranthum</i>	Combretaceae	Kinikiniba (f) ; Okan, okon (y, n)	Plant	Association Only	9,23	S
15	<i>Morinda lucida</i>	Rubiaceae	HWINSI (f) ; Oruwo, oju ologbo (y, n)	Leaf root bark	Association	8,71	T
16	<i>Ocimum americanum</i> Syn.: <i>Ocimum canum</i>	Lamiaceae	Kesu kesu, (f); Efinrin ata, (y, n)	Leaf	Association Only	8,46	H
17	<i>Vitellaria paradoxa</i> Syn.: <i>Butyrospermum paradoxu</i>	Scrophulariaceae	Wugo (f); èmi gidi (y, n)	Bark Leaf Root	Association	7,95	T
18	<i>Acanthospermum hispidum</i>	Asteraceae	Ahonglontétou (f)	Leaf Root	Association Only	7,18	H
19	<i>Cocos nucifera</i>	Arecaceae	Agonkè (tin) (f); Agbon, egbo agbon (y, n)	Root Leaf	Association	7,18	T
20	<i>Ehretia cymosa</i>	Boraginaceae	Misonma, Zozoma (f) ; jaoke (y, n)	Leaf	Association	9,74	S
21	<i>Lantana camara</i> Syn.: <i>L. aculeat</i>	Verbenaceae	Nyè ya (f); èwàn adele (y, n)	Plant	Association	6,92	H
22	<i>Carica papaya</i>	Caricaceae	Kpèn (tin) (f) ; Igi bèkpe (y, n)	Root Leaf Fruit	Association	6,92	H
23	<i>Sansevieria liberica</i>	Dracaenaceae	Kponyan (f, g), Oja koriko (y)	Root	Association Only	6,92	H
24	<i>Croton gratissimus</i> Syn.: <i>C. zambesticus</i>	Euphorbiaceae	Jelele (f, g); Ajeofole, oyiyi (y, n)	leaf	Association	6,67	S
25	<i>Phyllanthus amarus</i>	Euphorbiaceae	Henlenwe (f) ; Ashasha (y, n)	Root Leaf	Association Only	6,67	H

26	<i>Xylopiya aethiopica</i>	Annonaceae	Kpéjélékun (f); Erunje, (y)	Fruit	Association	6,67	T
27	<i>Pteleopsis suberosa</i>	Combretaceae	Kluikluitin (f)	Root Bark	Association	6,67	S
28	<i>Moringa oleifera</i>	Moringaceae	Kpatima (f)	Leaf	Association Only	6,67	S
29	<i>Lippia chevalieri</i> Moldenk Syn.: <i>L. adoensis</i>	Verbenaceae	Nyè ya (f); Efinrin gogoro (y, n);	Leaf	Association	6,41	S
30	<i>Citrus maxima</i> Syn.: <i>Aurantium maximum</i>	Rutaceae	Pomelo (angl)	Fruit Leaf	Association	6,15	T
31	<i>Psidium guajava</i>	Myrtaceae	Kenkun (f); Ewe goba (y, n)	Leaf	Association Only	6,15	S
32	<i>Sapillinia pinnata</i>	Sapindaceae	Adakloma (f, g); Ogbe okuje, (y, n)	Leaf	Association	5,13	L
33	<i>Chromolaena odorata</i> Syn.: <i>Eupatorium odoratum</i>	Asteraceae	Ketla imoleatu guhuma (y.n)	Plant	Association	4,62	S
34	<i>Spondias mombin</i>	Anacardiaceae	Akikontin, (f) ; Eekan (y, n)	Leaf	Association	4,36	T
35	<i>Piper nigrum</i>	Plumbaginaceae	Lènlènkun (f, g) ; Lyere atari (y, n).	Leaf	Association	4,36	L
36	<i>Uvaria chamae</i>	Annonaceae	zinwokokwe(f) ; okoaja (f, y)	Leaf Root	Association	4,36	S
37	<i>Caesalpinia pulcherrima</i>	Caesalpinioidae	Pride of Barbados (angl)	Leaf	Only	3,84	S
38	<i>Delonix regia</i> Syn.: <i>Poinciana regia</i>	Leguminosae- Caesalpinioidae	shèkè shèkè (y, n)	Leaf	Association Only	3,84	T
39	<i>Blighia sapida</i>	Sapindaceae	Lisetin (f); Igi ishin (y, n)	Leaf	Association	3,84	T
40	<i>Annona muricata</i>	Annonaceae	yovonyigwe (f); Sbisabi (y, n)	Feuille Ecorce	Association	3,84	S
41	<i>Adansonia digitata</i> Syn.: <i>Adansonia sphaerocarp</i>	Bombacaceae	Kpassa (f); Otché, oriri (y, n).	Leafed stem	Association Only	3,84	T
42	<i>Allium sativum</i>	Alliaceae	Ayo (f, g, y)	Fruit	Association	3,33	H
43	<i>Dioscorea cayenensis</i> Syn.: <i>D. aculeata</i>	Dioscoreaceae	Alakitcha, Magbanan (y)	Leaf	Association	3,33	H
44	<i>Citrullus lanatus</i> Syn.: <i>Colocynthis citrullus</i>	Cucurbitaceae	Goussi (f, g); Egoussi, (y, n)	Pulp	Association	3,08	H
45	<i>Arachis hypogaea</i>	Leguminosae- Papilionoideae	azin, aziin (f), épa (y, n)	Leaf	Association	2,56	H
46	<i>Croton lobatus</i>	Euphorbiaceae	Alovi aton, (f, g) ; ewele, onyan (y, n)	Leaf	Association	2,56	H
47	<i>Thalia geniculata</i> Syn.: <i>Thalia welwitschii</i>	Marantaceae	Aflema (f)	Leaf	Association Only	2,56	H
48	<i>Flueggea virosa</i> Syn.: <i>Securinega virosa</i>	Euphorbiaceae	Ccakè, kotama. (f); Igbado (y, n)	Leaf	Association	2,31	S
49	<i>Kigelia africana</i>	Bignoniaceae	Anon anon (f) ; Kkpandoro (y, n)	Leaf	Only	2,05	T
50	<i>Psorospermum febrifugum</i> Spach	Clusiaceae	Asukwasimalewu (f) ; Legun soko (y)	Leaf	Association	2,05	S
51	<i>Passiflora foetida</i>	Passifloraceae	Aavun nyèn mi trwi (f) ; Dagura (y, n)	Leaf	Association	2,05	H
52	<i>Lannea barteri</i>	Anacardiaceae	koraku (ba)	Bark	Association	2,05	T
53	<i>Microsorium scolopendria</i> Syn.: <i>Polypodium scolopendria</i>	Pteridophyta	Duma.jododewu (f) ; Degoma (g)	Leaf	Association	1,79	H
54	<i>Desmodium gangeticum</i>	Papilionoideae	Zédalman (f), Emino (y, n)	Leaf	Association	1,79	S
55	<i>Carissa spinarum</i> Syn.: <i>C. edulis</i>	Apocynaceae	Avia, aviaviè (f, g) ; Oshin shin (y n).	Root	Association	1,79	S
56	<i>Dialium guineense</i>	Leguminosae- Caesalpinioidae	Asèmswèn (f) ; Agiraja (y, n)	Leaf	Association	1,79	T
57	<i>Chamaecrista mimosoides</i> Syn.: <i>Cassia mimosoides</i>	Leguminosae- Caesalpinioidae	Tea senna (angl)	Leaf	Association	1,54	H
58	<i>Cola laurifolia</i> Mast	Sterculiaceae	Joloba (f) ; fomu(y)	Leaf	Association	1,54	T
59	<i>Picalima nitida</i> Syn.: <i>Tabernaemontana nitida</i>	Apocynaceae	Oanyè (f) ; Erin, Abe, Abere (y, n)	Leaf	Association	1,28	T
60	<i>Sorghum bicolor</i> Syn.: <i>S. vulgare</i>	Poaceae	agbokounvovo, kpkpo (f, g).	Leaf	Association	1,28	H
61	<i>Clerodendrum capitatum</i> Syn.: <i>Volkameria capitata</i>	Verbenaceae	Agonsweswe (f, g) ; Iye (y, n)	Leaf	Association	1,28	T
62	<i>Indigofera dendroides</i> Jacq Syn.: <i>I. sesbaniifolia</i>	Leguminosae- Papilionoideae	Agonagonma (f) ; Igogo (y, n)	Leaf	Association	1,28	S
63	<i>Alchornea cordifolia</i> Syn.: <i>Schousboea cordifolia</i>	Euphorbiaceae	Kamala (f) ; Ewe epa (y, n)	Leaf	Association	1,03	S
64	<i>Hibiscus asper</i> Hook.f	Malvaceae	Kpodé, (f)	Leaf	Association	1,03	H
65	<i>Garcinia kola</i>	Clusiaceae	Arowé (f); Orogbo (y, n)	Fruit	Association	1,03	T
66	<i>Macrosphyra longistyla</i>	Rubiaceae	Zigidi gowun (f); Ikunku èkun (y, n)	Leaf	Association	1,03	S
67	<i>Euphorbia hirta</i> Syn.: <i>Amyris anisata</i>	Euphorbiaceae	Hundi hundi asu (f); Emi Ile, (y, n);	Leaf	Association	1,03	H
68	<i>Clausena anisata</i> Syn.: <i>Amyris anisata</i>	Rutaceae	Gbozohouin (f)	Leaf	Association	1,03	S
69	<i>Amaranthus spinosus</i>	Amaranthaceae	Tètè ounon (f) ; Tètè élégoun (n)	Leaf	Association	1,03	H
70	<i>Hyptis suaveolens</i>	Lamiaceae	Azongbidi (f); Efinrin aja (y, n)	Leaf	Association	0,78	H
71	<i>Diodia sarmentosa</i> Syn.: <i>Diodia scandens</i>	Rubiaceae	JIWUHWE (ma) (f) ; Ehin aribo(y)	Bark	Association	0,78	H
72	<i>Voacanga ajricana</i>	Apocynaceae	leti (f) ; atakpari llbuko (y, n)	Fruit Leaf	Association	0,78	S
73	<i>Jatropha gossypifolia</i>	Euphorbiaceae	Nyikpotin vovo (f) ; Botuje pupa (y, n)	Leaf	Association	0,78	S
74	<i>Cassytha filiformis</i> Syn.: <i>C. guineensis</i>	Lauraceae	Abebekan (f) ; omoni gini gini (y)	Leaf	Association	0,78	H
75	<i>Erythrina senegalensis</i>	Leguminosae- Papilionoideae	Kpaklesi (f); Oshin shokojo (y, n)	Leaf	Association	0,78	T
76	<i>Lophira lanceolata</i> Syn.: <i>L. spatulata</i>	Ochnaceae	Wugo asu (f) ; Parihan (y.n)	Leaf	Association	0,78	T
77	<i>Caesalpinia bonduc</i>	Leguminosae-	Ajikun (f, g) ; Igi ayo, (y, n)	Seed	Association	0,78	S

	<i>Syn.: C. crista sens</i>	<i>Caesalpinioideae</i>					
78	<i>Keetia leucantha</i> <i>Syn.: Plectronia leucantha</i>	<i>Rubiaceae</i>		Leaf	Association	0,78	S
79	<i>Mangifera indica</i>	<i>Anacardiaceae</i>	amanga (f) ; mangoro (y, n)	Bark	Association	T	T
80	<i>Heliotropium indicum</i> <i>Syn.: H. africanum</i>	<i>Boraginaceae</i>	Koklosu denpaja (f) ; Ewe akuko (y)	Leaf	Association	0,78	H
81	<i>Lycopersicon esculentu</i> <i>Syn.: Solanum lycopersicum</i>	<i>Solanaceae</i>	Timati (f)	Leaf	Only	0,78	H
82	<i>Sebastiania chamaelea</i> <i>Syn.: Tragia chamaelea</i>	<i>Euphorbiaceae</i>	Ahehema, adoukin (f)	Leaf	Association	0,78	H
83	<i>Asparagus africanus</i> <i>Syn.: A. abyssinicus</i>	<i>Asparagaceae</i>	kpofèn (f) ; aluki (y)	Leaf	Association	0,78	H
84	<i>Trichosanthes cucumerina</i> <i>Syn.: T. anguina</i>	<i>Cucurbitaceae</i>	Timati yovoton (g)	Fruit	Seul	0,78	L
85	<i>Monodora myristica</i> <i>Syn.: Annona myristica</i>	<i>Annonaceae</i>	Sasalikun (f) ; Ariwo (y)	Fruit	Association	0,78	T
86	<i>Tetracera alnifolia</i> <i>Syn.: T. alnifolia</i>	<i>Dilleniaceae</i>	EWE OGBON (y)	Leaf	Association	0,51	L
87	<i>Crossopteryx febrifuga</i>	<i>Rubiaceae</i>	Gbatogba, (f); Ayeye, (y, n)	Leaf	Association	0,51	S
88	<i>Zornia glochidiata</i> <i>Syn.: Z. diphylla</i>	<i>Lentibulariaceae</i>	Lèkun lèkun (f); Reku reku (y, n).	Leaf	Association	0,51	H
89	<i>Bridelia ferruginea Benth</i>	<i>Euphorbiaceae</i>	Honsukokwe (f, g); Ira odan (y, n)	Leaf	Association	0,51	T
90	<i>Cyperus papyrus</i>	<i>Cyperaceae</i>	Ago (g)	Leaf	Association	0,51	H
91	<i>Microdesmis keayana</i> <i>Syn.: Microdesmis fluberula</i>	<i>Pandaceae</i>	Avi ahwi (g); Arin igo (y, n)	Leaf	Association	0,51	S
92	<i>Luffa cylindrica</i> <i>Syn.: L. aegyptiaca</i>	<i>Cucurbitaceae</i>	Assangokan (f, g) ; Erun (y, n)	Leaf	Association	0,51	L
93	<i>Schwenckia americana</i>	<i>Solanaceae</i>	Adagbonyanma (f) Igbale odan (y, n)	Leaf	Association	0,26	H
94	<i>Millettia thonningii</i>	<i>Leguminosae-Papilionoideae</i>	Otiétié (y)	Leaf	Association	0,26	T
95	<i>Hoslundia opposita</i>	<i>Lamiaceae</i>	Hlaciayooke àta (y)	Leaf	Association	0,26	S
96	<i>Bidens pilosa</i>	<i>Asteraceae</i>	Vodunga (f) Abèrèoloko (y)	Leaf	Association	0,26	H
97	<i>Ananas comosus</i> <i>Syn.: Bromelia comosa</i>	<i>Bromeliaceae</i>	agon (f, g) ; Ahun (y)	Fruit	Association	0,26	H
98	<i>Eichhornia natans</i>	<i>Pontederiaceae</i>	Jacinte d'eau (f)	Leaf	Association	0,26	H
99	<i>Cola nitida</i>	<i>Sterculiaceae</i>	Golo (tin) (f)	Leaf	Association	0,26	T
100	<i>Lanmea nigriflora</i> <i>Syn.: Odina nigriflora</i>	<i>Anacardiaceae</i>	Abobwe (f)	Leaf	Association	0,26	T
101	<i>Lanmea acida</i> <i>Syn.: L. egregia</i>	<i>Anacardiaceae</i>	Zuzu (f); Akuhu (y, n)	Leaf	Association	0,26	T
102	<i>Alternanthera sessilis</i> <i>Syn.: Gomphrena sessilis</i>	<i>Amaranthaceae</i>	Houngba (g)	Leaf	Association	0,26	H
103	<i>Musa sapientum</i>	<i>Orchidaceae</i>	Kokwé (f) ; Ogèdè loboyo (y, n)	Leaf	Association	0,26	H
104	<i>Tectona grandis</i>	<i>Verbenaceae</i>	Xwletin (f) ; Ikpatomu (y)	Leaf	Association	0,26	T
105	<i>Capsicum annum</i> <i>Syn. Capsicum chinense</i>	<i>Solanaceae</i>	Gbatakin (f, g)	Fruit	Association	0,26	H
106	<i>Zingiber officinale</i>	<i>Zingiberaceae</i>	Ginger (angl) ; Dotè (f)	Fruit	Association	0,26	H
107	<i>Commelina erecta</i>	<i>Commelinaceae</i>	Adokpokon (f); Ofele (y, n)	Leaf	Association	0,26	H
108	<i>Sida acuta Burm</i>	<i>Malvaceae</i>	adoma (f); oché kptou (y, n)	Leaf	Association	0,26	H
109	<i>Chenopodium ambrosioides</i>	<i>Chenopodiaceae</i>	azogbidiwa (f) ; emigbe (y, n)	Leaf	Association	0,26	H

The route of administration of the recipes is 99% oral followed by the nasal route.

Figure 5A shows the proportion of the different modes of administration of the plants, it follows that the decoction (91%) is the most used.

The analysis of fig. 5B shows that the part of the plants most used in anti-typhoid recipes consists of leaves with a proportion of 68%, followed by roots and barks with a proportion of 11% and 10% respectively. The least used organs are flowers (1%).

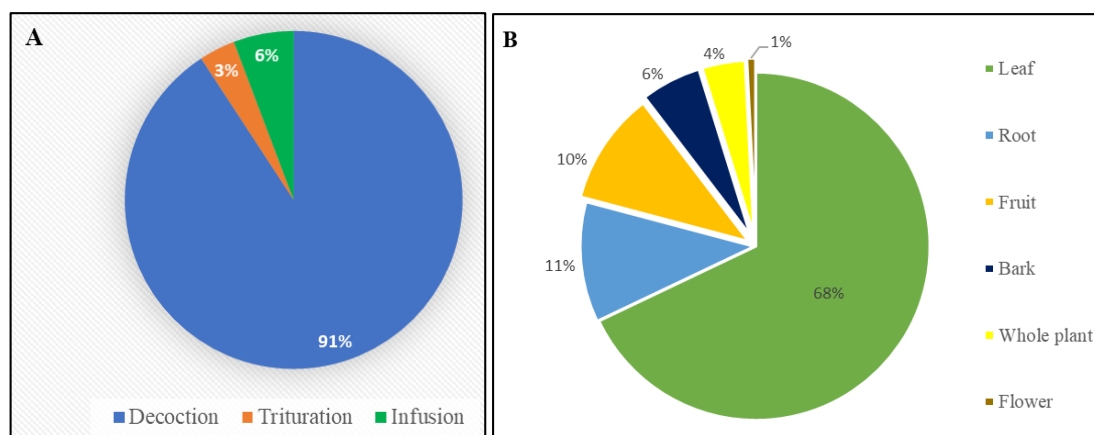


Fig 5: Proportion (%) of (A) different modes of plant administration, (B) organs (%) of medicinal plants

According to the results of the survey, we note that the 109 plant species are divided into 52 families. The best-represented families are : Euphorbiaceae

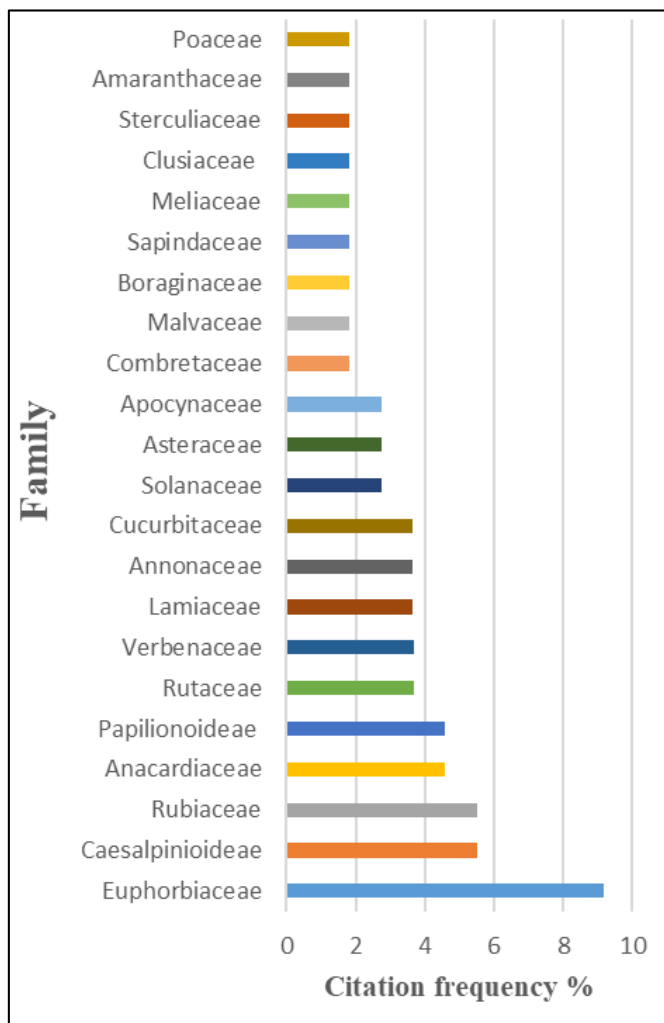


Fig 6: Proportions of species within families of registered medicinal plants

Discussion

The present study consisted of identifying and collecting information on plants used by the population of southern Benin to treat typhoid fever.

The results of this study showed that the respondents are more female. These results are consistent with the work of Mehdioui and Kahouadji [20] who showed that women are more in possession of traditional phytotherapy knowledge.

The knowledge of the uses of medicinal plants and their properties are generally acquired after a long experience accumulated and transmitted from one generation to the next. Experience accumulated with age is the main source of information at the local level. In particular, it has been recognized that in Africa, it is the elders, that is, older people, who hold the traditional knowledge of treating diseases. The results collected from the respondents show that the average age of the holders of medical plant recipes is 49 years. This may have been explained by the fact that the knowledge of traditional medicine is mainly transmitted from ascending (Wise) to descendants (Young). This is all the more justifiable because the majority of the people surveyed reported having inherited this knowledge from the family.

A total of 109 plants species have been identified. Leaves are the most used organs. The predominance of leaves is

indicated by other authors such as Mozouloua *et al.* [21] and Diatta *et al.* [22] who also showed that leaves are the plant organs most used in traditional medicine in the treatment of various diseases. The frequent use of leaves is justified by the abundance of the chemical groups they contain. They are the site of synthesis of secondary metabolites of the plant [23]. All these organs are prepared mainly in the form of decoction. This is due to the fact that the decoction can collect the most active ingredients and lessen or cancel the toxic effect of certain recipes [24]. Most recipes are consumed orally, this prescription can be explained by the fact that typhoid fever is a bacterial infection lodged in the intestine. Fruits of *Citrus aurantifolia* are most commonly used in typhoid fever recipes with a citation rate of 31.79%, followed by *Corchorus olitorius* (23.85%), *Senna siamea* (20.51%); this contribution from these plants shows their great use in traditional medicine. There is a little similarity between our results and that of Dougnon, who worked in some municipalities of the littoral, the Atlantic and the Ouémé. They revealed that the most commonly cited plants for the treatment of typhoid fever in humans are: *Persea americana* (22.72%), *V. amygdalina* (7.57%) and *Corchorus olitorius* (7.57%). This difference may be due to the size of the surveyed area and the professional diversity of the respondents whose work highlights.

Conclusion

The ethnopharmacological investigation allowed to build a database on the knowledge of the main plant species used in traditional medicine to treat typhoid fever in southern Benin. Analysis of this information reveals that there is a wealth and diversity of knowledge of the traditional use of medicinal plants in the treatment of typhoid fever. The most cited species are *Citrus aurantifolia*, *Corchorus olitorius*, *Senna siamea*, *Zanthoxylum zanthoxyloides*, *Sarcocephalus latifolius*, *Dichapetalum madagascariense*, *Ocimum gratissimum*, *Cratogeomys adansonii*, *Jatropha multifida* and *Khaya senegalensis*. These data will be used for the valorization of medicinal plants treating typhoid fever in the perspective to discovering new anti-typhoid active ingredients and formulate phytomedicines, in order to control the multi-resistance of *Salmonella* to existing antibiotics.

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