



PHARMACOVIGILANCE OF MEDICINAL PLANTS: CONTRIBUTION OF THE HERBALISTS IN ABIDJAN

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ABSTRACT

To identify indications and safety of medicinal plants sold by herbalists on different markets in Abidjan. An ethnobotanical study was conducted on five markets in Abidjan, the economic capital of Cote d'Ivoire in West Africa (*Abobo, Adjamé, Marcory, Port-Bouët* and *Treichville*). Data were collected from herbalists about local names in *Malinké* and *Baoulé* languages, plant parts used, mode of remedy preparations, route of administration, indications, potential adverse reactions or toxic effects; families and species of plants were given by a botanist. We collected 49 recipes for various indications. 62 species that belonged to 32 families were recorded. We had 56 names of plants in *Baoulé*, 68 in *Malinké*. The names of 7 plants (in *Malinké* or *Baoulé*) were not identified because no sample was available. The most important indications were urogenital diseases and infections. The herbalists described some adverse reactions and toxic effects. The adverse reactions mentioned by the herbalists were digestive (n=16 recipes, 32.7%), neurological (n=13 recipes, 26.5%), general (n=9 recipes, 18.4%), gyneco-obstetric (n=6 recipes, 12.3%) and cutaneous (n=2 recipes, 4.1%). Five of the six most frequently reported species in the recipes (*Citrus aurantifolia*, *Jatropha curcas*, *Momordica charantia*, *Anogeissus leiocarpus* and *Vernonia colorata*) were indicated to induce abortion or treat malaria. Herb sellers described herbal remedies as effective and safe. Their knowledge could permit to identify adverse reactions and toxic effects using a local language like *Malinké*. But the population must be informed about the potential risks of herbal remedies.

Key words: Medicine, Traditional, Adverse effects, Ethnopharmacology, Herbalists.

INTRODUCTION

The use of "modern" drugs is reported to be limited for African populations owing to their high cost and their supposed toxic reputation. So in these recent years people are increasingly using "alternative" or "complementary" medicine. Nearly 80% of the African population use herbal remedies for health care needs because they have limited financial resources (Ake Assi *et al.*, 1991). Herbal remedies are considered as an ancestral knowledge, not dangerous because natural. Also, they are

widely available at low cost; that leads to self-medication (Ake Assi *et al.*, 1991; Esiyok, 2004). Most herbalists specialized in picking and selling plants on different markets are coming from bordering countries. Thus, plants sold in Cote d'Ivoire can come from various countries. The language of exchange of these herbalists was *Malinké*. This trading language is also commonly used in Cote d'Ivoire compared to *Baoulé*, which is a specific and local language.

This situation raises questions about the real benefit and safety of these medicinal plants. Many cases of intoxication were reported without identifying the incriminated plant(s) although these plants are generally bought on the markets (Binlin-Dadie *et al.*, 1997). The

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aim of this study was to identify, with the help of herbalists, medicinal plants bought by the population on markets of Abidjan and to assess the herbalists' knowledge on their potential benefits and risks.

METHODOLOGY

Study area

An ethnobotanical study was performed on the markets of the districts of Abidjan: *Abobo*, *Adjamé*, *Marcory*, *Port-Bouët* and *Treichville* (Figure 1). Abidjan is the economic capital of Cote d'Ivoire, over 2,119 km² with 4,351,086 inhabitants in 2014 (density was 2,053.4 inhabitants/km²) (INS, 2014). Abidjan is divided into northern-Abidjan and Southern-Abidjan by the Ebrie lagoon. Northern-Abidjan is the continental part of Abidjan. Southern-Abidjan is the part located on the strip of land along the lagoon. The selected areas in the study are dormitory towns where live low-income populations. Abobo district located in the north of Northern-Abidjan, is one of the most populated districts: approximately 1,500,000 inhabitants for 90 km², density 16,667 inhabitants/km² (INS, 2014). Adjamé is also a district of Northern-Abidjan, located in the north of Plateau district. The districts of Marcory, Port-Bouet and Treichville are all in Southern-Abidjan. Port-Bouet spreads out along the coast over ten kilometers beyond the Vridi channel. In the covered markets found in these districts, stalls of food (vegetables, fruit, meat, fish) are near stalls of medicinal plants, pieces of pottery, kitchen utensils and other goods. *Malinké* is a trading language shared with three border countries of Cote d'Ivoire (in the west, Guinea; in the north, Mali and Burkina Faso). There is a great trading exchange and circulation of population between these countries. *Baoulé* is a language only used in Cote d'Ivoire.

Administration of questionnaire

For this study a specific questionnaire with nine items was used. It concerned the names of plants in local languages (*Malinké* and *Baoulé*), plant parts used, mode of remedy preparations, route of administration, indications, potential adverse reactions or toxic effects, family and species. Trained interviewers administered this questionnaire. Herbalists present on the markets were questioned on the first seven items of this questionnaire after obtaining their consent. When the consent was refused, no question was asked.

Authentification of plants

A sample of each plant available was collected (free of charge or bought). The families and species were identified by one of the authors of this study (AAL). Then samples were recorded in the voucher.

RESULTS

Herbalists reported 49 recipes (Table 1) that concerned 69 medicinal plants belonging to 62 species

and 32 families; 7 plants mentioned by the herbalists were not identified because no sample was available (Table 2). The herbalists gave names of 56 plants (82.6%) in *Baoulé*, 68 (98.6%) in *Malinké*, and 56 (82.6%) in both languages. For 10 plants, herbalists gave only one local name: 9 in *Malinké* and one in *Baoulé* (Table 2). For the 7 plants not identified, 4 had a name in *Malinké* (Mourou, Soumahoro mawa, Baboukari, Cotamani mogou), one with a name in *Baoulé* (Noufé) and two with name both in *Malinké* and *Baoulé* (Bobo/Beya, Ofa/Ofa) (Table 1).

About the 49 recipes, herbalists mentioned adverse reactions in 35 recipes (71.4% of recipes), toxic effects in 5 recipes (10.2% of recipes) and no adverse reactions in 7 recipes (14.3% of recipes). They did not give adverse reactions information in 2 recipes (4.1% of recipes).

The recipes were monocomponents, bicomponents and multicomponents respectively in 24 (49.0% of recipes), 12 (24.5% of recipes) and 13 (26.5% of recipes). In multicomponent recipes, 6 recipes consisted of 3 plants, 3 recipes of 4 plants, 2 recipes of 5 plants, 1 recipe of 6 plants and one recipe of 20 plants (Table 1). The mean number of adverse reactions mentioned by herbalists in monocomponent, bicomponent or multicomponent recipes and standard deviation were respectively 1 ± 0.56 (range 0-2), 2 ± 1.00 (range 0-3) and 3 ± 1.07 (range 0-4) ($r=0.501$, $p < 0.0001$). The mean number of indication and standard deviation were 1 ± 0.68 (range 1-4), 2 ± 1.7 (range 1-7) and 2 ± 1.2 (range 1-5) ($r=0.248$, $p > 0.05$). No adverse reactions information was mentioned for 2 recipes of 3 plants (Table 1). For the 49 recipes, the adverse reactions mentioned by the herbalists were digestive (n=16 recipes, 32.7%), neurological (n=13 recipes, 26.5%), general (n=9 recipes, 18.4%), gynecological (n=6 recipes, 12.3%), cutaneous (n=2 recipes, 4.1%). The other adverse reactions mentioned were haemorrhage and blindness (one recipe each; Table 1). The digestive adverse reactions mentioned by the herbalists in 16 recipes, included vomiting (10/16 recipes), diarrhea (5/16 recipes), rectal haemorrhage (3/16 recipes), and abdominal pain (1/16 recipes). The neurological adverse reactions according to the herbalists in the 13 recipes, included dizziness (8/13 recipes), loss of consciousness (7/13 recipes), somnolence and fall off one's height (1/13 recipes each). The general adverse reactions mentioned in 9 recipes were asthenia (6/9 recipes), adynamia (5/9 recipes), and hyperthermia (1/9 recipes). The gynecological ones in 6 recipes, included abortion (5/6 recipes), metrorrhagia (1/6 recipes), and uterine perforation (1/6 recipes). The cutaneous adverse reactions in 2 recipes were eruption (2/2 recipes) and pruritus (1/2 recipes).

The species of plants mostly quoted by herbalists in the recipes with digestive adverse reactions were *Momordica charantia*, *Nauclea latifolia* and *Oxal*

subscorpioides; those with neurological adverse reactions were *Morinda lucida*, *Nauclea latifolia*, *Vernonia colorata*; those with general adverse reactions were *Momordica charantia*; and those with gynecological-obstetric adverse reactions were *Anogeissus leiocarpus*, *Jatropha curcas*. We noted that *Momordica charantia*, *Vernonia colorata* and *Anogeissus leiocarpus* were frequently involved in the recipes with digestive, general, neurological and gynecological-obstetric adverse reactions (Table 3).

Globally the indications of the recipes mentioned by herbalists were urogenital diseases (20 recipes, 40.8%) such as to induce abortion (10 recipes) and amenorrhea (4 recipes); infectious diseases (18 recipes, 36.7%) including malaria (14 recipes); digestive diseases (10 recipes, 20.4%) such as hemorrhoids (5 recipes) and constipation (5 recipes; Table 1). Five of the six most frequently quoted species in the recipes (*Citrus aurantifolia*, *Jatropha curcas*, *Momordica charantia*, *Anogeissus leiocarpus* and *Vernonia colorata*; Table 2) were indicated to induce abortion or treat malaria.

According to herbalists the recipes used to induce abortion (n=10 recipes) could cause loss of consciousness (30.0% of recipes), asthenia (20.0% of recipes), adynamia, eruption, pruritus, hyperthermia, dizziness, abortion and uterine perforation (10.0% of the recipes each). Herbalists mentioned no adverse reactions

information in one recipe. The recipes used for amenorrhea (n=4 recipes) caused diarrhea (50.0% of recipes), rectal haemorrhage (50.0% of recipes), haemorrhage and abortion (25.0% of recipes). Adverse reactions related to the recipes used to treat hemorrhoids (n=5 recipes) were diarrhea (60.0% of recipes), rectal haemorrhage (40.0% of recipes), adynamia, haemorrhage and asthenia (20.0% of recipes in each case). As for recipes used to treat malaria (n=14 recipes), the adverse reactions were mostly vomiting (42.9% of recipes), dizziness (28.6% of recipes), diarrhea, loss of consciousness, asthenia, adynamia (14.3% of recipes in each case), rectal haemorrhage, eruption, abortion and toxic effects (7.1% of recipes in each case; Table 1). From the recipes which had abortive effect according to herbalists (indication or adverse reactions), we collected sixteen species of plants: 2 (*Cassia alata* and *Calotropis procera*) had only abortive adverse reactions, 8 (*Momordica charantia*, *Fagara zanthoxyloides*, *Harungana madagascariensis*, *Vernonia colorata*, *Trichilia emetica*, *Solanum lycopersicum*, *Parquetina nigrescens* and *Vismia guineensis*) had abortive indication and 6 (*Jatropha curcas*, *Anogeissus leiocarpus*, *Gossypium hirsutum*, *Citrus aurantifolia*, *Ocimum gratissimum* and *Ricinus communis*) had both abortive adverse reactions and abortive indication.

Table 1. Adverse effects and indications of recipes described by herbalists in the five markets in Abidjan

N°	Recipe combination and indication(s)	Adverse effects
1	Infusion or decoction of <i>Nauclea latifolia</i> roots mixed with powder of Mourou "boule noir"*** is drunk to treat hypertension, hemorrhoids, urinary infection, impotency (sexual), malaria, amenorrhea or constipation	Diarrhea, rectal haemorrhage
2	Infusion of <i>Cassia sieberiana</i> roots, Ofa* roots, <i>Fagara zanthoxyloides</i> roots, <i>Securidaca logipedunculata</i> roots, <i>Canthium kraussoides</i> roots, Ladj fofana** leaves is drunk to treat hemorrhoids, urinary infection, impotency (sexual), amenorrhea, constipation	Diarrhea, rectal haemorrhage
3	Infusion or decoction of <i>Azalia africana</i> (bark, roots), <i>Lophira lanceolata</i> bark, <i>Trichilia emetica</i> roots is used by oral and rectal routes to treat uterine fibroid	Vomiting, dizziness
4	<i>Azalia africana</i> roots, Soumahoro mawa** leaves, <i>Calotropis procera</i> leaves, Baboukari** bark were prepared as decoction or pulverization and drunk to treat uterine fibroid	Dizziness, metrorrhagia, rectal haemorrhage
5	Trituration of <i>Solanum rugosum</i> leaves is used locally for cutaneous wound	Intoxication if drinking
6	Infusion of <i>Calotropis procera</i> (bark, roots) is used by rectal route to treat pregnant asthenia	Abortion
7	Decoction of Cotamani mougou** roots is drunk to treat hemorrhoids	Diarrhea, adynamia
8	<i>Momordica charantia</i> seeds and chloroquine tablets are crushed in <i>Citrus aurantifolia</i> juice and is used as rectal suppository to induce abortion or to treat furuncle	Eruption, pruritus, malaria, loss of consciousness
9	Rectal use of decoction of leaves and roots of <i>Morinda lucida</i> and <i>Nuclea latifolia</i> to treat malaria	Dizziness, loss of consciousness
10	Infusion of <i>Momordica charantia</i> and <i>Opilia celtidifolia</i> leaves is used by oral and rectal routes to treat malaria	Dizziness, vomiting, eruption
11	Decoction of <i>Azadirachta indica</i> and <i>Persea americana</i> leaves is used by oral and rectal routes to treat malaria	Dizziness

12	Local use of crushed <i>Solanum rugosum</i> leaves to treat cutaneous wound	Toxic or death if drinking
13	<i>Vernonia colorata</i> , <i>Combretum molle</i> and <i>Uapaca somon</i> leaves decoction is used for bath and beverage to treat pruritus	Asthenia
14	Rectal use of crushed <i>Vernonia colorata</i> leaves and <i>Trichilia emetica</i> roots to induce abortion	Dizziness, loss of consciousness
15	Triturated or crushed <i>Momordica charantia</i> leaves with <i>Citrus aurantifolia</i> juice are mixed in white wine of palm-tree or water for drink to treat urinary infection or helminthiasis	Vomiting
16	<i>Khaya senegalensis</i> barks infusion is drunk daily to treat malaria, wound of belly, anorexia or to wash blood	Asthenia, adynamia
17	<i>Pteleopsis suberosa</i> bark decoction is drunk to treat wound of belly	Somnolence (children of 6 months-1 year)
18	Infusion or decoction of <i>Bridelia ferruginea</i> , <i>Pteleopsis suberosa</i> , <i>Khaya senegalensis</i> barks is drunk to treat chronic diseases: chronic slimming	Not mentioned
19	<i>Olox subscorpioidea</i> leaves infusion is drunk to treat malaria	Vomiting
20	Decoction of <i>Olox subscorpioidea</i> bark of roots is drunk to clean the belly	Vomiting
21	<i>Entada sudanica</i> barks maceration for drunk to treat malaria	Vomiting
22	Infusion or trituration of <i>Cassia alata</i> leaves or crushed is drunk to treat constipation or tinea	Severe diarrhea
23	<i>Cassia italica</i> leaves infusion is drunk as tee to treat constipation or to Slim	Fall its height, loss of consciousness
24	Crushed of <i>Gossipium hirsutum</i> and <i>Solanum lycopersicum</i> leaves for rectal use to induce abortion	No adverse effect
25	Infusion or decoction of <i>Vernonia colorata</i> and <i>Azadirachta indica</i> leaves is drunk to treat malaria	Vomiting, dizziness antidote : red oil
26	<i>Erythrophleum guineense</i> leaves crushed and decoction are drunk for a true test	Intoxication (death)
27	<i>Cassia alata</i> leaves trituration or crushed are mixed in <i>Citrus aurantifolia</i> juice. It used by oral and rectal routes to treat tinea and shingles	Abortion
28	Rectal use of <i>Gossipium hirsutum</i> and <i>Jatropha curcas</i> leaves crushed is associated to the drink of <i>Parquetina nigrescens</i> leaves infusion to induce abortion	Not mentioned
29	<i>Jatropha curcas</i> stem of leaves. The sap is introduced in intra-uterin orifice to induce abortion	Loss of consciousness, uterine perforation
30	Decoction of Noufê* leaves drink is toxic (intoxication)	Severe vomiting
31	Maceration of <i>Momordica charantia</i> leaves and liana (whole plant) is drunk to treat malaria	Asthenia, vomiting
32	<i>Cardiospermum grandiflorum</i> stems dried is crushed and use in oral and rectal routes to treat hemorrhoids, or for non gravidic amenorrhea	Haemorrhage
33	Crushed of <i>Cassia occidentalis</i> seeds is drunk to treat malaria	Toxic
34	Infusion or trituration or crushed of <i>Cassia alata</i> , <i>Citrus aurantifolia</i> , <i>Anogeissus leiocarpus</i> and <i>Jatropha curcas</i> leaves is drunk to treat malaria or constipation	Abortion
35	Trituration or crushed or decoction of <i>Anogeissus leiocarpus</i> leaves is used by rectal or orale route to treat amenorrhea	Abortion
36	Leaves and stems of <i>Amaranthus viridis</i> , <i>Elytraria maritima</i> , <i>Struchium sparganophora</i> , <i>Solenostemon monostachyus</i> , <i>Pentodon pentandrus</i> used with powder of Kaolin (white) were macerated and used by rectal route to treat female sterility	No adverse effect
37	<i>Momordica charantia</i> leaves trituration or crushed is used as rectal suppository to induce abortion	Asthenia, hyperthermia
38	Infusion or decoction of <i>Cassia occidentalis</i> , <i>Citrus aurantifolia</i> , <i>Cymbopogon citratus</i> leaves is drunk to treat pregnant malaria	No adverse effect
39	Decoction of <i>Alstonia boonei</i> bark is mixed with Tip Tonic® for drinking to treat malaria	Vomiting
40	<i>Crotalaria retusa</i> leaves decoction for drinking to induce abortion	No adverse effect
41	<i>Bryophyllum pinnatum</i> leaves sap, and trituration or crushed were drunk for truth test	Dangerous (toxic)
42	Sap of <i>Elaeophorbia grandifolia</i> leaves is used in eyes for truth test	Blindness

43	Maceration of <i>Jatropha curcas</i> leaves is used for bath to treat malaria	No adverse effect
44	Decoction of <i>Fagara zanthoxyloides</i> roots and bark and <i>Harungana madagascariensis</i> roots is drunk and used also by rectal route to induce abortion	No adverse effect
45	Decoction of <i>Fagara zanthoxyloides</i> roots and bark, <i>Harungana madagascariensis</i> roots and <i>Vismia guineensis</i> bark is used by oral and rectal routes to induce abortion	No adverse effect
46	Mixture of Beya* bark, <i>Rauvolfia vomitoria</i> roots and leaves, <i>Anthocleista djalonensis</i> roots and bark, <i>Alstonia boonei</i> bark and leaves, <i>Harungana madagascariensis</i> bark and leaves, <i>Uvaria chamae</i> roots, <i>Olox subscorpioidea</i> roots, <i>Adenia lobata</i> liana, <i>Cochlospermum planchonii</i> roots, <i>Nauclea latifolia</i> roots and leaves, <i>Morinda lucida</i> roots and leaves, <i>Vitex grandifolia</i> leaves, <i>Trema guineensis</i> leaves, <i>Cassia siamea</i> leaves, <i>Azadirachta indica</i> leaves, <i>Anogeissus leiocarpus</i> leaves, <i>Paullinia pinnata</i> leaves, <i>Alchornea cordifolia</i> leaves, <i>Vernonia colorata</i> leaves, <i>Manodes longiflora</i> leaves is used for fumigation or the decoction by oral and rectal routes to treat malaria, jaundice, « White Malaria » and salmonellosis	If more than 1 glass twice by day: diarrhea, dizziness, adynamia, loss of consciousness
47	<i>Cassia alata</i> leaves, <i>Mareya micrantha</i> leaves decoction is drunk to treat diarrhea	Adynamia, dizziness
48	<i>Jatropha curcas</i> leaves, <i>Gossypium hirsutum</i> leaves, <i>Anogeissus leiocarpus</i> leaves, <i>Ricinus communis</i> leaves, <i>Ocimum gratissimum</i> leaves crushed is used by rectal route to induce abortion	Adynamia, asthenia, abdominal pain 3 days ago then abortion
49	<i>Securidaca longipedunculata</i> roots, <i>Swartzia madagascariensis</i> roots, <i>Trichilia emetica</i> roots, Ofâ** roots decoction or infusion is used by oral and rectal routes to treat hemorrhoids or wound of belly	Asthenia

* name in Baoulé ** name in Malinké

Table 2. Frequency of medicinal plants mentioned with local names in the recipes described by the herbalists on the markets

Species	Family	Local name in Malinké	Local name in Baoulé	Frequency (n=49 recipes)
<i>Citrus aurantifolia</i> (Christm. & Panzer) Swingle	Rutaceae	Lomouroucoumouni	Wahourélomi	5 (10.2%)
<i>Jatropha curcas</i> L.	Euphorbiaceae	Bakanibrou	Plôplô	5 (10.2%)
<i>Momordica charantia</i> L.	Cucurbitaceae	Nonvonni, Trègué	Ndagnama, Nda ngna	5 (10.2%)
<i>Anogeissus leiocarpus</i> (DC.) Wallich.	Combretaceae	Kerèkètè, Kalama	Souroubouet	4 (8.2%)
<i>Cassia alata</i> L.	Caesalpinaceae / Leguminosae / Fabaceae	Kababrou	Gbokô	4 (8.2%)
<i>Vernonia colorata</i> (Willd.) Drake.	Asteraceae / Compositae	Kôssaflan, Korossafina	Abowi	4 (8.2%)
<i>Azadirachta indica</i> A. Juss.	Meliaceae	Acacia kacounan	Malihirin, Dédaigna	3 (6.1%)
<i>Fagara zanthoxyloides</i> Lam.	Rutaceae / Fagaceae	Wô, Houo	Tchéché, Tchintchébowi	3 (6.1%)
<i>Gossypium hirsutum</i> L.	Malvaceae	Conlonibrou	Djécé	3 (6.1%)
<i>Harungana madagascariensis</i> Lam. ex Poire.	Hypericaceae / Clusiaceae / Guttiferae	Sograni	Modjamodja	3 (6.1%)
<i>Nauclea latifolia</i> Smith.	Rubiaceae	Bati	Atèrèrè, Tôlè	3 (6.1%)
<i>Olox subscorpioides</i> Oliv.	Olacaceae	Kôssoumara	Akandjé	3 (6.1%)
<i>Trichilia emetica</i> Vahl.	Meliaceae	Soulafizan	Sourafizan	3 (6.1%)
<i>Azalia africana</i> Sm. ex Pers.	Caesalpinaceae / Leguminosae / Fabaceae	Linguè	Kpakpa	2 (4.1%)
<i>Alstonia boonei</i> De Wild.	Apocynaceae	Kôgbè,	Amihan,	2 (4.1%)

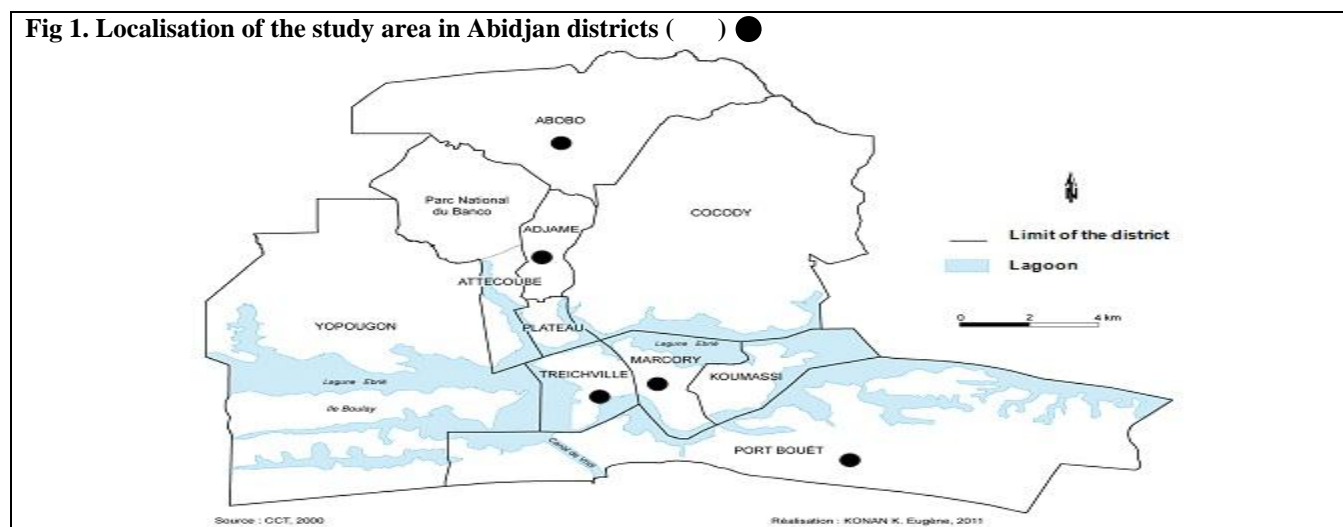
		Soukonamissinni	Emihin	
<i>Annona senegalensis</i> Pers.	Annonaceae	Souzougbe	Amlon	2 (4.1%)
<i>Calotropis procera</i> (Aiton) W.T. Aiton	Asclepiadaceae	Fogôfogô	Troumba	2 (4.1%)
<i>Cassia occidentalis</i> L.	Caesalpiniaceae / Leguminosae / Fabaceae	Kangaliba, Baranbaran	Matrancancan madagna	2 (4.1%)
<i>Khaya senegalensis</i> (Desr.) A. Juss.	Meliaceae	Djala	Loucroubowi	2 (4.1%)
<i>Morinda lucida</i> Benth.	Rubiaceae	Galababrou	Koya	2 (4.1%)
<i>Pteleopsis suberosa</i> Engl. & Diels	Combretaceae	Trenifou (liane)	Térendin	2 (4.1%)
<i>Securidaca longipedunculata</i> Fresen.	Polygalaceae	Djorolilé	Noro	2 (4.1%)
<i>Solanum rugosum</i> Dunal.	Solanaceae	Mossifaga	Koumossi	2 (4.1%)
<i>Adenia lobata</i> (Jacq.) Engl.	Passifloraceae	Lorossiridjourou	Ahirégnaman	1 (2.0%)
<i>Alchornea cordifolia</i> (Schumach. & Thonn.) Müll. Arg.	Euphorbiaceae	Koyaranbrou	Djéka	1 (2.0%)
<i>Amaranthus viridis</i> L.	Amaranthaceae	Borongbêni	Kplafani oufouet	1 (2.0%)
<i>Anthocleista djalensis</i> A. Chev.	Loganiaceae	Fanta ladèbè	Wowoliho	1 (2.0%)
<i>Bridelia ferruginea</i> Benth.	Euphorbiaceae	Sagba, Dafin, Saguin	Séha	1 (2.0%)
<i>Bryophyllum pinnatum</i> (Lam.) Kurz.	Crassulaceae	Sôkossôkobrou	Akpôligbli yassoua	1 (2.0%)
<i>Canthium kraussioïdes</i>	Connaraceae	Ladji fofana	-	1 (2.0%)
<i>Cardiospermum grandiflorum</i> Sw.	Sapindaceae	Cocomalan	Kpèkpè	1 (2.0%)
<i>Cassia italica</i> (Mill.) Spreng.	Caesalpiniaceae / Leguminosae / Fabaceae	Balibali	-	1 (2.0%)
<i>Cassia siamea</i> Lam.	Caesalpiniaceae / Leguminosae / Fabaceae	Acacia gbèman	Acacia oufoué	1 (2.0%)
<i>Cassia sieberiana</i> DC.	Caesalpiniaceae / Leguminosae / Fabaceae	Sidjan	-	1 (2.0%)
<i>Cochlospermum planchonii</i> Hook.f.	Cochlospermaceae	Tribala	Lélébrôdjécé	1 (2.0%)
<i>Combretum molle</i> R.Br. ex G.Don	Combretaceae	Wagnagabrou, Nganianka	Yassoua yaka	1 (2.0%)
<i>Crotalaria retusa</i> L.	Papilionaceae / Leguminosae / Fabaceae	Bilanan	Téréyèrèmain	1 (2.0%)
<i>Cymbopogon citratus</i> (DC.) Stapf	Poaceae / Gramineae	Loucrobile	Magnérin	1 (2.0%)
<i>Elaeophorbium grandifolia</i> (Haw.) Croizat	Euphorbiaceae	Lôlô	-	1 (2.0%)
<i>Elytraria maritima</i>	Acanthaceae	Tohountoni	Gninbodalié	1 (2.0%)
<i>Entada sudanica</i> Guill. & Perr.	Mimosaceae / Leguminosae / Fabaceae	Samaderè	Djakouadiofou hou	1 (2.0%)
<i>Erythrophleum guineense</i> G.Don.	Caesalpiniaceae / Leguminosae / Fabaceae	Tali, Talifi	Alouï	1 (2.0%)
<i>Lophira lanceolata</i> Tiegh. ex Key	Ochnaceae	Mannan	Amanibowi	1 (2.0%)
<i>Manotes longiflora</i> Baker.	Connaraceae	Hirigblèni	Kplakassa	1 (2.0%)
<i>Mareya micrantha</i> (Benth.) Müll. Arg	Euphorbiaceae	Tchèbanicala	-	1 (2.0%)
<i>Ocimum gratissimum</i> L	Lamiaceae / Labiatae	Soukounan	Aromagni, Magniné	1 (2.0%)
<i>Opilia celidifolia</i> (Guill. & Perr.) Endl. ex	Opiliaceae	Korongbé	-	1 (2.0%)

Walp.				
<i>Parquetina nigrescens</i> (Afzel.) Bullock.	Periplocaceae / Asclepiadaceae	Souahé	Sourobouet (du village)	1 (2.0%)
<i>Paullinia pinnata</i> L.	Sapindaceae	Koussamanafon	Trodi	1 (2.0%)
<i>Pentodon pentandrus</i> (Schaumach. & Thonn.) Vatke.	Rubiaceae	Karikari	Boubougblè	1 (2.0%)
<i>Persea americana</i> Mill.	Lauraceae	Avouca, Pya	Afouca	1 (2.0%)
<i>Rauwolfia vomitoria</i>	Apocynaceae	Malankala	Wakakpéikpéi, Gnawi	1 (2.0%)
<i>Ricinus communis</i> L.	Euphorbiaceae	Djomadjoma	Atèdè	1 (2.0%)
<i>Solanum lycopersicum</i> L.	Solanaceae	Tomati	Tomati	1 (2.0%)
<i>Solenostemon monostachyus</i> (P.Beauv.) Briq.	Lamiaceae / Labiatae	Bassakoun	Zissiwrowro	1 (2.0%)
<i>Struchium sparganophora</i> (L.) Kuntze.	Asteraceae / Compositae	Kôsoussofi	Wouzifihin	1 (2.0%)
<i>Swartzia madagascariensis</i> Desv.,	Caesalpinaceae / leguminosae / Fabaceae	Samankara	Boto	1 (2.0%)
<i>Trema guineensis</i> Schumach. & Thonn.	Ulmaceae	Sodécola	Agnician	1 (2.0%)
<i>Uapaca somon</i> Aubrév. & Leandri.	Euphorbiaceae	Somonbrou	Amonron man	1 (2.0%)
<i>Uvaria chamae</i> P.Beauv.	Annonaceae	Hirifi	Anvou	1 (2.0%)
<i>Vismia guineensis</i> (L.) Choisy.	Hypericaceae / Clusiaceae / Guttiferae	Djara	Loukrou	1 (2.0%)
<i>Vitex grandifolia</i> Gürke	Verbenaceae	Kôto, Koro	Ngbligna	1 (2.0%)

Table 3. Plants in the recipes mostly related to adverse effects according to herbalists

Adverse effects	Plants involved	Number of recipes
Digestive	<i>Momordica charantia</i> L.	3
	<i>Nauclea latifolia</i> Smith.	3
	<i>Olax subscorpioides</i> Oliv.	3
	<i>Securidaca longipedunculata</i> Fresen.	2
	<i>Vernonia colorata</i> (Willd.) Drake.	2
	<i>Fagara zanthoxyloides</i> Lam.	2
	<i>Cassia sieberiana</i> DC.	2
	<i>Canthium kraussioides</i>	2
	<i>Azadirachta indica</i> A. Juss.	2
	<i>Anogeissus leiocarpus</i> (DC.) Wallich.	2
<i>Alstonia boonei</i> De Wild.	2	
Neurology	<i>Morinda lucida</i> Benth.	5
	<i>Nauclea latifolia</i> Smith.	5
	<i>Vernonia colorata</i> (Willd.) Drake.	5
	<i>Azadirachta indica</i> A. Juss.	4
	<i>Trichila emetica</i> Vahl.	3
	<i>Azalia africana</i> Sm. ex Pers.	2
	<i>Cassia italica</i> (Mill.) Spreng.	2
	<i>Momordica charantia</i> L.	2
General	<i>Momordica charantia</i> L.	3
	<i>Anogeissus leiocarpus</i> (DC.) Wallich.	2
	<i>Gossipium hirsutum</i> L.	2
	<i>Jatropha curcas</i> L.	2
	<i>Khaya senegalensis</i> (Desr.) A. Juss.	2
	<i>Ocimum gratissimum</i> L.	2
	<i>Ricinus communis</i> L.	2

	<i>Vernonia colorata</i> (Willd.) Drake.	2
Gyneco-obstetric	<i>Anogeissus leiocarpus</i> (DC.) Wallich.	3
	<i>Jatropha curcas</i> L.	3
	<i>Cassia alata</i> L.	2
	<i>Citrus aurantifolia</i> (Christm. & Panzer) Swingle	2
	<i>Calotropis procera</i> (Aiton) W.T. Aiton	2
Cutaneous	<i>Momordica charantia</i> L.	3
	<i>Citrus aurantifolia</i> (Christm. & Panzer) Swingle	2
Intoxication	<i>Solanum rugosum</i> Dunal	2



DISCUSSION

This study showed that herbalists knew not only the vernacular names of plants in *Baoulé* and in *Malinké* but they also knew the safety profile (adverse reactions and toxic effects) of their recipes, even if we did not assess the accuracy of their knowledge on this safety profile. In fact, that was't the subject of our study. They Show that medicinal plants had adverse reactions which is contrary to popular assertion. In the popular conscience the medicinal plants are soft without adverse effect; therefore, plants are widely used in the world by many people including children and pregnant women and also as food without any care contrary to modern medicines (Nordeng *et al.*, 2004; Esiyok *et al.*, 2004). We must pay attention to their safety profile. We realized that they were aware of the adverse effects (Rodrigues and Barnes, 2013; Neergheen-Bhujun, 2013). Only 2 among 49 recipes had not adverse reaction information mentioned and 14, 3% of the recipes are safe. This study showed also that the number of adverse reactions reported by the sellers increased significantly with the number of plants in the recipes as described. The adverse and toxic effects are various and could be serious. For this reason we must involve herbalists in adverse plant reaction monitoring system.

Despite their beneficial effects, medicinal plants can cause intoxication or death (Kamagate *et al.*, 2005;

Koltin *et al.*, 2006; Neergheen-Bhujun, 2013). The adverse effects described by the sellers were mainly digestive and neurological. *Momordica charantia*, *Vernonia colorata*, *Anogeissus leiocarpus* were frequently included in the recipes with digestive, general, neurological and gyneco-obstetric adverse reactions.

The gynaecological effect mostly needed by women customers is abortion, which is well known by herb sellers (van Andel *et al.*, 2014). From a recent study in the three university hospitals of Abidjan, the main reasons of plant consumption leading to hospitalization in an intensive care unit were firstly abortion attempts (35.5%) followed by suicide attempts (29.0%), medical aetiologies (19.3%) and accidental aetiologies (13.0%) (Die-Kakou *et al.*, 2009). Percentage of abortion was high in 1994. In an intensive care unit 65.0% of patients used plants to induce abortion, 25.0% for usual treatment, 5.0% for sterility and 5.0% for severe constipation) (Binlin *et al.*, 1997).

In the literature, no case of gynaecological effect was found using plants of the current study apart from *Calotropis* and *Momordica charantia* (Rao, 1971; Leung *et al.*, 1997). The most common method to induce abortion involved insertion of *Calotropis gigantea* shrub sticks into the cervix. In the present study herbalists reported the same method with *Jatropha curcas* (n°29 of table 1). Most of the time, other people performed the

abortion in 90% of cases. It was performed by women themselves in 10% (Rao, 1971).

This survey also revealed that, taking a bath with the leaves of *Jatropha curcas* seems not to be toxic (n°43). But, when *Jatropha curcas* is associated either to *Gossypium hirsutum* and *Parquetina nigrescens* (n°28) or to *Cassia alata*, *Citrus aurantifolia* and *Anogeissus leicarpus* (n°34) or to *Gossypium hirsutum*, *Anogeissus leicarpus*, *Ricinus communis*, and *Ocimum gratissimum* (n°48), it had an abortive effect. Probably the synergistic effect of these plants is also required. The abortive effect of *Momordica charantia*, was due to Alpha momorcharin. The mechanism may be related to the ribosome-inhibiting activity of the protein (Leung *et al.*, 1997).

The toxic potential of these plants explains why they are generally used in abortion or in suicide attempts (Die-Kakou *et al.*, 2009; Binlin *et al.*, 1997; van Andel *et al.*, 2014). The complications are multivisceral, neurological, hematologic, infectious and respiratory. The mortality rate is very high between 37.5% and 65%. But, generally, plants remain unknown (Die-Kakou *et al.*, 2009). Herbalists claimed that there were risks for intoxication with some plants. Plants identified in this study, confirmed that. They included *Solanum rugosum* (Nwude *et al.*, 1980), *Erythrophleum guineense* (Echeverria *et al.*, 1986), *Cassia occidentalis* (Vashishtha *et al.*, 2009; Yadav *et al.*, 2010), *Bryophyllum pinnata* (McKenzie *et al.*, 1986) and *Elaeophorbia grandifolia*. Their toxicity was related to their chemical composition (Neergheen-Bhujun, 2013; van Andel *et al.*, 2014).

To identify adverse or toxic effects related to plants in traditional medicine, the language is very important. Compared to *Baoulé*, most of the plants had a name in *Malinké*. The extensive use of *Malinké* indicates that this language may be used in future studies in the Abidjan area.

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The number and the species of plants included in the recipes seem to be controlled by herbalists too. Although, the composition of the recipes varies according to the indication, the number of indications by recipe is stable and do not exceed 7 in this study. Medicinal plant recipes are kept secret in each family, because they provide sellers or herbalists with fame and respect in the society (Panghal *et al.*, 2010). Therefore plants are not labelled on the market. For example, seven plants were not identified because sellers refused to give us samples; maybe to protect the composition of the recipes. For example, herbalists sometimes used the name of the person who designed the original recipe (*e.g.* Soumahoro Mawa), the seller's name (*e.g.* Baboukari or Ladji Fofana), the color of the product (*e.g.* "Boule noire" which means to "Blackball"), or an other name (*e.g.* Cotamani) which hampered identification of plant or reconstitution of recipe in the absence of samples.

CONCLUSION

Herbalists not only help to describe herbal remedies as effective and safe, but they also help to identify adverse and toxic effects based on their knowledge using local languages like *Malinké*. Only few recipes seem safe. The adverse and toxic effects identified are various and could be serious. For this reason, herbalists must be involved in adverse plant reaction monitoring system. The experience of traditional medicine practitioners can help to enhance traditional medicine.

ACKNOWLEDGEMENTS

The authors thank Dr Philip Robinson of Pharmacology department of Bordeaux 2 for his grateful help. This article has not received a funding and has no conflict of interest.

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