



(RESEARCH ARTICLE)



Inventory of plants used in the treatment of viral diseases, sold on markets in the district of Abidjan

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Abstract

This survey, which took place in the midst of the Covid 19 global health crisis, was conducted on medicinal plants used in the traditional treatment of the most common viral diseases in Côte d'Ivoire. The aim was to inventory the plant species sold and collect ethnopharmacological data related to these plants.

Semi-structured interviews were conducted with herbalists in nine markets in the district of Abidjan. The information collected was processed using SPSS 17.0 computer and statistical software. This study revealed that shingles, yellow fever and chickenpox are the viral diseases for which there are more traditional remedies. A total of 61 species of antiviral medicinal plants distributed in 59 genera and 54 botanical families were identified. Fabaceae (14.75 %), Asteraceae (9.8 %), and Apocynaceae (9.8 %) are the most represented families. Six species are most commonly used in the treatment of viral diseases. They are, in decreasing order of frequency of use: *Ocimum gratissimum*, *Citrus aurantiifolia*, *Spondias mombin*, *Allium sativum*, *Gymnanthemum amygdalinum*, *Kalanchoe crenata*. The leaves are the most used parts, in the form of a decoction (73.84 %). This is consistent with the predominance of the beverage (39.62 %) as a form of use and the oral route of administration (42 %).

This study, which allowed the collection of ethnomedicinal data, is positioned as an orientation in the search for effective active ingredients against emerging ET re-emerging viral diseases.

Keywords: Plants; Viral Diseases; Antiviral; Herbalist; Côte d'Ivoire

1. Introduction

There are many viral diseases, ranging from the mildest to the most serious. They are often transmissible and can take the form of an epidemic. Among the best known are angina, the common cold, influenza, chicken pox, measles, hepatitis B, herpes, AIDS and more recently Covid-19. Some of these are real public health problems affecting many countries, both developed and developing. In 2019, 36 million people were living with HIV [1] and today, the whole world is fighting the Covid-19 pandemic which has already caused at least 6 million deaths [2]. Unfortunately, like AIDS and Covid-19, for many viral pathologies, there are still no official pharmaceutical specialities to cure them efficiently and a lower

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cost. This is why the use of traditional medicine to combat these diseases is encouraged by the WHO [3]. But with deforestation, many plants are threatened and much local knowledge has disappeared. Therefore, for Betti [4 ;5], it is important to carry out ethnobotanical studies to identify the local uses of plant species for health purposes. In Côte d'Ivoire, several ethnobotanical and ethnopharmacological studies have been conducted on medicinal species, their recipes as well as the forms of use for the realization of a pharmacopoeia. Thus, Ambé et al. [6] highlighted several anti-diarrheal plants while N'guessan et al. [7] and Wangny et al. [8] respectively characterized anti-malarial plants and plants used against hypertension. However, very little work has been done on antiviral plants. Hence the interest of this study, in the current global health context. While Vroh Bi [9] carried out a bibliographic review of plants used against the symptoms of Covid-19 in sub-Saharan Africa, our study on the other hand is focused on the antiviral plants used in Côte d'Ivoire. The general objective of this study is to contribute to the search for plant-based drugs against certain viral diseases. Specifically, it will identify, characterize and catalog some plants used in the treatment of viral diseases. To achieve this, we first conducted an ethnopharmacological survey on plants used against viral diseases and sold in the markets of three communes in the district of Abidjan. We then processed the data from this survey. This study, which is part of the valorization of natural substances, is the starting point for the identification of antiviral properties of certain tropical medicinal plants and the search for new antiviral active principles.

2. Material and methods

2.1. Study site

Our study took place in the central, northern and western parts of the autonomous district of Abidjan, the economic capital in the south of Côte d'Ivoire. The survey took place in markets in the communes of Adjamé, Abobo and Yopougon. These communes are adjacent to the Banco forest (Fig. 1) and are the primary sites for wholesale distribution of medicinal plants. In addition, these communes have the largest sales markets for medicinal plants.

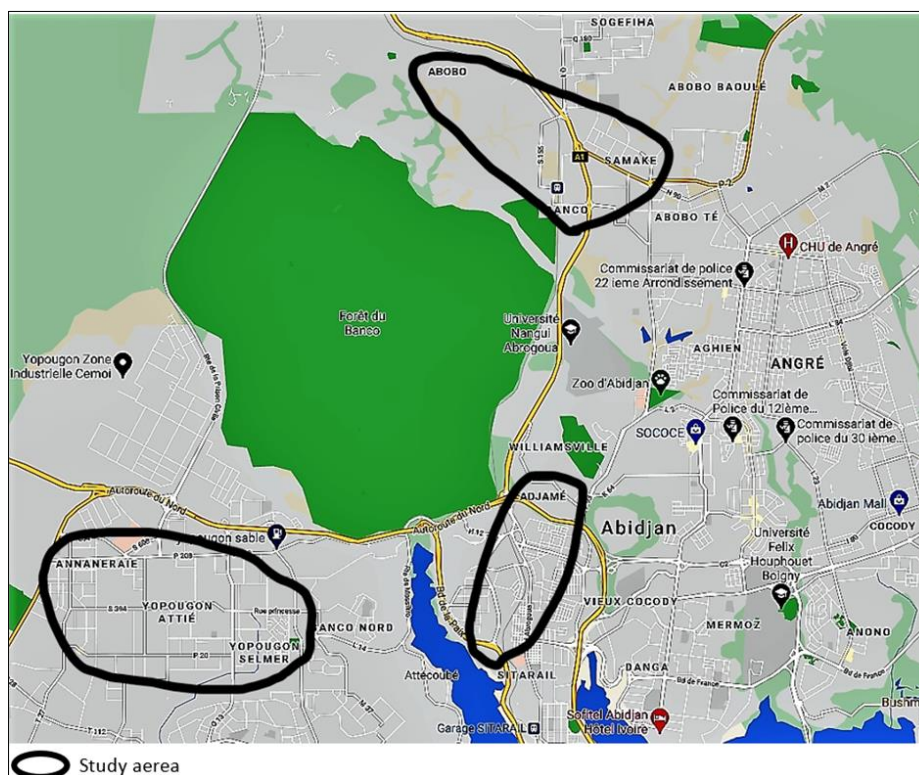


Figure 1 Study sites in the city of Abidjan

2.2. Material

The material consists of all the medicinal plants used in the treatment of viral diseases and the classic technical material for collecting information. These include survey forms (see Appendix 1), newsprint, paper wrappers, paper tape, a camera and a dictaphone.

2.3. Data collection

In this study, the survey was conducted on medicinal plants used in the treatment of viral diseases and the different methods of use by herbalists for the treatment of these conditions. Data collection was conducted using the semi-structured interview technique [10; 11; 12; 13] and was conducted in a total of nine markets. Each interview was accompanied by the purchase of medicinal plants marketed and used for the treatment of viral diseases. These purchases constituted collections of specimens that were identified at the National Center of Floristics, University Félix HOUPOUET-BOIGNY. The ethnopharmacological survey was conducted with 32 herbalists. Individual interviews were conducted with the herbalists who were available and who agreed to answer the questions. During the interviews, the information collected concerned the profile of the herbalists (gender, age and experience), ethnobotanical and ethnopharmacological data such as local names of the species, the parts of plants used, the modes of preparation and use, the routes of administration and the dosage.

2.4. Data processing

The data collected during this survey was processed as follows: the tabulation of the survey forms followed by the statistical analysis of the results. Thus, the responses to the questionnaires were tabulated, coded, entered and processed using the EXCEL 2016 spreadsheet. These data were statistically processed using XLStat version 2014 software. The citation frequency (Fc) of each plant was determined by the following formula.

$$F_c = \frac{NC}{N_t} \times 100$$

Where Nc is the number of citations for the plant under consideration and Nt is the total number of citations for all plants.

As for the statistical analysis of the data, the Chi-square (χ^2) test was the only statistical test used in this study to compare the frequencies of use of the organs, modes of preparation, modes of administration, and routes of administration of the different plants used in viral conditions. These data were processed using XLStat software version 2014.5.03 (XLStat, 2014). When a difference exists between two or more frequencies at the 5% threshold, the Chi-square test is completed using the procedure of Marascuilo and Serlin [14]. Marascuilo's procedure involves performing pairwise comparison tests for all pairs of proportions, which identifies the proportions responsible for the existence of linkage.

3. Results and discussion

The surveys included 32 herbalists, all of whom were female. Their ages varied between 18 and 55 years. Their number of years of experience in the commercialization of medicinal plants varies between 01 and 15 years.

3.1. Diseases treated

This survey focused on the treatment of 10 viral diseases which are shingles, yellow fever, chickenpox, influenza, colds, viral hepatitis, angina, mumps, measles and AIDS. Among these diseases, those most treated by the plants sold in the three municipalities are shingles, yellow fever and chickenpox with citation rates that vary between 18.28% and 21.51%. Mumps, measles and AIDS do not seem to be sufficiently treated with medicinal plants (Table 1).

Table 1 Citation frequencies for viral diseases

Diseases	Number of citations	Percentage (%) ¹
shingles	20	21.51 ^a
yellow fever	17	18.28 ^a
chickenpox	17	18.28 ^a
flu	13	13.98 ^{ab}
common cold	12	12.9 ^{ab}
viral hepatitis	6	6.45 ^{ab}
angina	5	5.38 ^{ab}

mumps	1	1.08 ^b
measles	1	1.08 ^b
AIDS	1	1.08 ^b
Statistical parameters of the Chi-square test²		
dl	9	
χ^2	62.18	
P	< 0.001	

¹For each parameter, the percentages followed by the same letters are not significantly different; ($\alpha = 0.05$). ²dl: degree of freedom; χ^2 : statistical value of the Chi-square test; P: Probability

3.2. Richness and composition of the plants surveyed

During this study, 61 species of medicinal plants used against viral diseases were identified by herbalists in the city of Abidjan. This shows the floristic richness of the plants sold in the markets visited. Moreover, according to Monteiro et al. [15], in general, the medicinal plants sold on the markets have an average of one hundred species. The 61 species of antiviral plants identified in this study are divided into 59 genera and 54 botanical families. The most represented families are Fabaceae (14.75%), Asteraceae (9.8%), and Apocynaceae (9.8%). These first two families are also recognized as such in the surveys of Guinnin et al. [16], who worked on anti-viral plants. The species most known by traders for the treatment of viral conditions are in decreasing order of citation frequency: *Ocimum gratissimum*, Citrus lemon, *Spondias mombin*, *Allium sativum*, *Gymnanthemum amygdalinum*, *Kalanchoe crenata* (Table 2). None of these plants are among the threatened species of the Ivorian flora. Most of the plants identified in this study and the plants of the traditional pharmacopoeia in general, are woody plants, as evidenced by the previous work of several authors [17; 18; 19].

3.3. Characteristics of drugs and their uses in the treatment of viral diseases

3.3.1. Parts used

Leaves are the most used parts in the preparation of herbal medicines against viral diseases, with a citation rate of 65.15%. All other plant forms or organs such as stem barks, fruits, roots, leafy twigs, whole plants and rhizomes, have statistically similar frequencies of use (Table 3). The predominance of leaves, is in agreement with the work of Diatta et al. [18], Gueye et al. [20], Zerbo et al. [19] and Zirihi [21], who also showed that leaves are the most used plant organs in traditional medicine in the treatment of various ailments. This predominance is also explained by the richness of secondary metabolites in leaves. The leaf is the site of biosynthesis of these phytomolecules [22; 23; 24]. They are generally rich in terpenoids including some with antiviral potency, such as lupeol, betulinic acid and others [25; 26].

3.3.2. The modes of preparation

This study revealed five modes of preparation of the medicinal recipes which are decoction, incineration, aqueous maceration, kneading and trituration. For the treatment of viral diseases, most of the plants used are prepared in the form of decoction. This method of preparation represents 73.84% (Table 4). Indeed, as water is the most used solvent, for an efficient extraction of thermoresistant active ingredients, decoction is the best indicated preparation. Moreover, decoction allows to destroy or cancel the toxicity of some compounds [6; 27] and to eliminate the microorganisms sheltered by the plant materials.

Table 2 Ethnobotanical characteristics of the plants surveyed

SCIENTIFIC NAMES	FAMILIES	SPECIMEN NUMBERS	USED PARTS	FREQUENCY OF CITATION FC	VERNACULAR OR COMMON NAMES (LOCAL LANGUAGE)	TREATED DISEASES	PREPARATION METHODS	METHODS OF ADMINISTRATION	DOSAGE
<i>Acanthospermum hispidum</i> DC	Asteraceae	UCJ003383	Leaves	0.45%	sourakanouéni (Malinké)	chicken pox	decoction	beverage	2 times a day
<i>Adenia lobata</i> (Jacq.) Engl.	Passifloraceae	UCJ014196	Leaves	0.45%	arèman (Malinké)	shingles	decoction	bath and enema	2 times a day
<i>Aframomum melegueta</i> K. Schum	Zingiberaceae	UCJ017668	Fruits	0.90%	kpahibè (bété) maniguette (french)	angina	kneading	cutaneous application	1 time a day
<i>Ageratum conizoides</i> (L.) L.	Asteraceae	UCJ003411	Leafy branches	1.36%	aboklô (Baoulé), Roi des herbes (french)	cold, flu	trituration	Nasal instillation	2 times a day
<i>Allium sativum</i> L.	Amaryllidaceae	Allium	Fruits	8.63%	ail (french)	chicken pox, shingles	kneading, aqueous maceration	cutaneous application, enema, beverage	1 time a day
<i>Aloe buettneri</i> A. Berger	Xanthorrhoeaceae	UCJ011322	Leaves	0.45%	aloès (french)	shingles	kneading	cutaneous application	2 times a day
<i>Alstonia boonei</i> De Wild.	Apocynaceae	UCJ001553	Stem barks	2.72%	Emien (baoulé, agni)	chicken pox	decoction	beverage, bath	2 times a day
<i>Anchomanes difformis</i> (Blume) Engl.	Araceae	UCJ002331	Leaves	0.45%	dina tali (Yacouba), dé (Malinké), bédro - bédro (Bété)	flu	decoction	beverage	2 times a day
<i>Artemisia annua</i> L.	Asteraceae	Artemisia	Leaves	0.45%	Artemisia (french)	flu	decoction	beverage	2 times a day
<i>Azadirachta indica</i> A. Juss.	Meliaceae	UCJ012262	Leaves	0.45%	Nime (french)	flu, yellow fever	decoction	beverage	2 times a day
<i>Bambusa vulgaris</i> Schrad.	Poaceae	UCJ006786	Leaves	0.45%	Bambou de chine (french)	yellow fever	decoction	beverage	2 times a day
<i>Piliostigma thonningii</i> (Schum.) Milne-Redh.	Fabaceae	UCJ009483	Leaves	0.45%	gnamanbou (malinké)	chicken pox	decoction	beverage, bath and enema	2 times a day

<i>Bersama abyssinica</i> subsp. <i>paullinioides</i> (Planch.) Verdc.	Meliaceae	UCJ012391	Roots	0.45%	lèglègbégbéhi (bété)	cold	aqueous maceration	Nasal instillation	1 time a day
<i>Guilietina bonduc</i> Griseb.	Fabaceae	UCJ009109	Leaves	0.45%	awalé (baoulé)	chicken pox	decoction	beverage, bath	2 times a day
<i>Calotropis procera</i> (Aiton) Dryet.	Apocynaceae	UCJ002509	Leaves	0.45%	toupatou (Côte d'Ivoire)	shingles	decoction	beverage	2 times a day
<i>Carica papaya</i> L.	Caricaceae	UCJ002676	Leaves	0.45%	papayebrou (malinké)	chicken pox	decoction	beverage	2 times a day
<i>Citrus aurantiifolia</i> (Christm.) Swingle	Rutaceae	CSRS006370	Leaves	11.36%	citron (french)	chicken pox, hepatitis, shingles, angina, rougeaole	decoction	beverage, cutaneous application	2 times a day
<i>Cymbopogon citratus</i> (DC.) Stapf	Poaceae	UCJ007004	Leaves	0.90%	Citronnelle (french)	cold, flu, yellow fever	decoction	beverage	2 times a day
<i>Elaeis guineensis</i>	Arecaceae	UCJ014116	Fruits	0.45%	Ayé (Agni), gohlo (bété)	shingles	incineration	cutaneous application	2 times a day
<i>Eucalyptus platyphylla</i> F.Muell.	Myrtaceae	<i>Eucalyptus</i>	Leaves	0.90%	Djoum (Malinké)	Yellow fever	decoction	beverage, bath	2 times a day
<i>Funtumia elastica</i> (Preuss) Stapf	Apocynaceae	UCJ002015	Stem barks	0.45%	gnahsou (bété)	Yellow fever	decoction	beverage	2 times a day
<i>Gliricidia sepium</i> (Jacq.) Walp.	Fabaceae	UCJ010419	Leaves	0.45%	gliricidia	flu	decoction	beverage	2 times a day
<i>Gossypium hirsutum</i> L.	Malvaceae	UCJ011821	Leaves	1.36%	conibou (malinké) feuille de coton (cote d'ivoire)	cold, chicken pox, yellow fever	decoction	beverage, bath	2 times a day
<i>Holarrhena floribunda</i> (G.Don) T.Duret & Schinz	Apocynaceae	UCJ002020	Stem barks	0.45%	kouna sana (Malinké), torotoro (Gouro de Sinfra), sagéi (Bété) sébé (Baoulé)	shingles	kneading	cutaneous application	1 time a day

<i>Hoslundia opposita</i> Vahl	Lamiaceae	UCJ008830	Leaves	0.45%	anomalié (Agni, Baoulé), zakrolebakro (Bété)	cold, flu	trituration /decoction	Nasal instillation/ beverage	2 times a day
<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	UCJ006119	Leaves	0.45%	aploplo (baoulé)	mumps	kneading	cutaneous application	2 times a day
<i>Kalanchoe crenata</i> (Etrews) Haw.	Crassulaceae	UCJ004319	Leaves	5.45%	akpolegli (baoulé) ,feuille lourde lourde	cold, flu	trituration	Nasal instillation	2 times a day
<i>Khaya senegalensis</i> (Desv.) A.Juss.	Meliaceae	UCJ012302	Stem barks	2.27%	djala (malinke)	chicken pox, shingles	decoction	bath, beverage and enema	2 times a day
<i>Lawsonia inermis</i> L.	Lythraceae	UCJ011747	Leaves	0.45%	djabibrou (malinké)	yellow fever	decoction	Bath, beverage and enema	2 times a day
<i>Mangifera indica</i> L.	Anarcadiaceae	UCJ000983	Leaves/ Stem barks	0.45%	manguier male	yellow fever, shingles	decoction	bath, beverage and enema	2 times a day
<i>Mikania cordata</i> (Burm.f.) BLRob.	Asteraceae	UCJ003775	Leafy branches	1.81%	kpitakpita azalai (agni)	cold, yellow fever, chicken pox shingles	decoction	bath, beverage, nasal instillation and enema	2 times a day
<i>Momordica charantia</i> L.	Cucurbitaceae	UCJ004434	Leaves	0.45%	crékété (malinké)	hepatitis	decoction	beverage, enema	2 times a day
<i>Sarcocephalus latifolius</i> (Sm.) EABruce	Rubiaceae	UCJ015407	Leaves/ root barks /Root	2.72%	bati(malinké) ,tété (baoulé)	chicken pox, hepatitis	decoction	bath, beverage and enema	2 times a day
<i>Newbouldia laevis</i> (P .Beauv.) Semble.	Bignoniaceae	UCJ001965	Stem barks	0.45%	hysope (french)	shingles	decoction	bath, enema	2 times a day
<i>Nicotiana tabacum</i> L	Solanaceae	UCJ016861	Leaves	0.45%	asragnan (agni)	shingles	kneading	cutaneous application	2 times a day

<i>Ocimum americanum</i> L.	Lamiaceae	UCJ008873	Leaves	2.27%	soukola (malinké)	cold, yellow fever	decoction, trituration	Nasal instillation, bath and enema	2 times a day
<i>Ocimum gratissimum</i> L.	Lamiaceae	UCJ008876	Leaves	14.54%	amangniné (baoule)	cold, flu, angina	decoction, trituration	Nasal instillation beverage	2 times a day
<i>Olax subscorpioides</i> Oliv.	Olacaceae	UCJ013253	Leaves	0.90%	akindjé (agni), wanwan-yiri (gouro)	hepatitis, chicken pox	decoction	beverage, enema	2 times a day
<i>Cryptolepis calophylla</i> (Baill.) L. Joubert & Bruyns	Apocynaceae	UCJ014295	Leaves	0.45%	sroboué (baoulé)	shingles	kneading	cutaneous application	2 times a day
<i>Paullinia pinnata</i> L.	Sapindaceae	UCJ016410	Leaves	0.90%	trondi (baoulé), iridjanbrou (malinké)	yellow fever	decoction	beverage, bath	2 times a day
<i>Phyllanthus amarus</i> Schumach. & Thonn.	Phyllanthaceae	UCJ006242	Whole plant	0.45%	dénanco (malinké), mille-maladies (french)	cold	decoction	beverage	2 times a day
<i>Pseudarthria hookeri</i> Wight & Arn.	Fabaceae	UCJ010930	Leaves/ Roots	0.45%	tilibala (malinké)	angina	decoction	Steam suction	2 times a day
<i>Pterocarpus erinaceus</i> Poir.	Fabaceae	UCJ010935	Stem barks	0.45%	gbin (malinké)	shingles	decoction	bath, enema	2 times a day
<i>Ricinus communis</i> L.	Euphorbiaceae	UCJ006333	Leaves	0.45%	solokofala (malinké)	shingles	decoction	beverage, bath, enema	2 times a day
<i>Rauvolfia vomitoria</i> Afzel.	Apocynaceae	UCJ002178	Leaves	0.45%	gnawi (baoulé)	chicken pox	decoction	bath	2 times a day
<i>Flueggea virosa</i> (Roxb. ex Willd.) Royle	Phyllanthaceae	UCJ006375	Leaves	0.45%	mokrodoma (Malinké)	cold	trituration	nasal instillation	1 time a day
<i>Senna alata</i> (L.) Roxb.	Fabaceae	UCJ009126	Leaves	0.90%	djorouba brou (malinké)	flu	decoction	beverage	2 times a day
<i>Senna occidentalis</i> (L.) Link	Fabaceae	UCJ009170	Leaves	0.90%	kinkéliba (malinké)	yellow fever	decoction	beverage, bath	2 times a day
<i>Sida acuta</i> Burm.f.	Malvaceae	UCJ011954	Leafy branches	0.45%	kélékolaka (baoulé), barillé (malinké)	aids	aqueous maceration	enema	1 time a day

<i>Spondias mombin</i> L.	Anarcadiaceae	UCJ001020	Leaves	10.45%	tromagna (baoule) mirabelle (french) mosambrou (malinké)	chicken pox, shingles, hepatitis	decoction	beverage, bath, cutaneous application, enema	2 times a day
<i>Stylosanthes erecta</i>	Fabaceae	UCJ011041	Leaves	0.45%	dofaga (malinké)	yellow fever	decoction	beverage	2 times a day
<i>Tamarindus indica</i> L.	Fabaceae	UCJ009522	Leaves	0.45%	tomi (malinké)	chicken pox	decoction	beverage	2 times a day
<i>Tectona gretis</i> L.f.	Lamiaceae	UCJ017491	Leaves	0.45%	téki (gouro)	yellow fever, flu	decoction	beverage	2 times a day
<i>Terminalia glaucescens</i> Planch. ex Benth.	Combretaceae	UCJ003137	Leaves	0.45%	wolo (malinké)	flu, yellow fever	decoction	beverage	2 times a day
<i>Tithonia diversifolia</i> (Hemsl.) A.Gray	Asteraceae	UCJ003863	Leaves	2.72%	atindé (baoulé), marguerite (french)	chicken pox, shingles, yellow fever	decoction	beverage, bath, enema and cutaneous application	2 times a day
<i>Trema orientalis</i> (L.) Blume	Cannabaceae	UCJ017317	Leaves	0.45%	sodomkola (malinké)	Yellow fever	decoction	beverage, bath	2 times a day
<i>Gymnanthemum amygdalinum</i> (Delile)) Sch.Bip. ex Walp.	Asteraceae	UCJ003893	Leaves	6.36%	cohsafnan (malinké), abowi (baoulé)	chicken pox, shingles	decoction	beverage, bath, enema and cutaneous application	2 times a day
<i>Vitellaria paradoxa</i> C.F.Gaertn	Sapotaceae	UCJ016458	Fruits	0.45%	beurre de karité (french)	shingles	decoction	cutaneous application	2 times a day
<i>Xylopia aethiopica</i> (Dunal) A.Rich.	Annonaceae	UCJ001462	Fruits	0.45%	loro (bété), fondé (Abé), efromou (Agni)	flu	decoction	beverage	2 times a day
<i>Zanthoxylum zanthoxyloides</i> (Lam.) Zepern. & Timler	Rutaceae	UCJ016155	Stem barks /root barks	1.36%	kédjé (baoulé)	shingles, hepatitis, angina	decoction	cutaneous application, beverage	2 times a day
<i>Zingiber officinale</i> Roscoe	Zingiberaceae	Zingiber	Rhizomes	0.90%	gnamankou (malinké), gingembre (french)	cold	decoction	beverage	2 times a day

Table 3 Frequency of use of different plant organs

Parts used	Number of citation	Percentage (%) ¹
Leaves	43	65.15 ^a
Stem Barks	9	13.64 ^b
Fruits	5	7.56 ^b
Roots	4	6.06 ^b
Leafy branches	3	4.55 ^b
Whole plant	1	1.52 ^b
Rhizomes	1	1.52 ^b
Total	66	100
Statistical parameters of the Chi-square test²		
dl	6	
χ^2	168.247	
P	< 0.001	

¹For each parameter, the percentages followed by the same letters are not significantly different; ($\alpha = 0.05$). ²dl: degree of freedom; χ^2 : statistical value of the Chi-square test; P: Probability

Table 4 Methods of preparation of medicinal plants

Method of preparation	Number of citation	Percentage (%) ¹
decoction	48	73.84 ^a
incineration	1	1.54 ^b
Aqueous maceration	3	4.62 ^b
kneading	7	10.77 ^b
trituration	6	9.23 ^b
Statistical parameters of the Chi-square test²		
dl	5	
χ^2	179.68	
P	< 0.001	

¹For each parameter, the percentages followed by the same letters are not significantly different; ($\alpha = 0.05$). ²dl: degree of freedom; χ^2 : statistical value of the Chi-square test; P: Probability

3.3.3. The ways and modes of administration

The medicinal preparations derived from the plants surveyed are administered by four routes, the oral route, the cutaneous application, the anal route and the nasal route. The oral and cutaneous routes are the most favoured with respective rates of 42% and 32% (Fig. 2)

Indeed, the ways of administration are related to the modes of administration. In the traditional treatment of viral diseases, this study reveals that most of the plants listed are used in the form of beverage (39.62%), then sometimes by oral aspiration of steam hence the predominance of the oral or buccal route as shown in the work of Guinnin et al. [16]. Then the preparations are administered in the form of bath or by local application to borrow the cutaneous way. Some are administered in the form of enema by anal route while others are used by nasal instillation. Besides the preparations in the form of beverages, which are the most frequent practices in the administration of phytotherapies against viral diseases, the intake of these medicines in the form of baths, enema and by local application, are modes of administration that appear with similar frequency (Table 5). The intake of antiviral medicinal recipes in the form of beverage then oral

and cutaneous applications are privileged here because most of the viral diseases targeted in this study, are systemic diseases, which alter the internal organs and which sometimes, have cutaneous applications manifestations (yellow fever, chicken pox, flu, measles etc). Thus, to reach their targets, bioactive phytocompounds must reach the bloodstream through the digestive system.

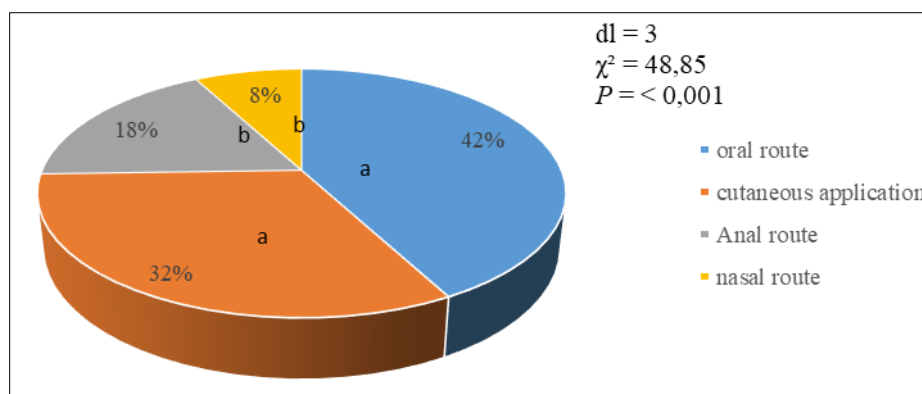


Figure 2 Comparison of the routes of administration of traditional medicines in the treatment of viral diseases

Table 5 Methods of administration of medicinal preparations

Methods of administration	Number of citation	Percentage (%) ¹
Beverage	42	39.62 ^a
Bath	22	20.76 ^b
Enema	18	16.98 ^b
Cutaneous application	15	14.15 ^b
Nasal instillation	8	7.55 ^{bc}
Steam suction	1	0.94 ^c
Statistical parameters of the Chi-square test ²		
dl	5	
χ^2	78.83	
P	< 0.001	

¹For each parameter, the percentages followed by the same letters are not significantly different; ($\alpha = 0.05$). ²dl: degree of freedom; χ^2 : statistical value of the Chi-square test; P: Probability

4. Conclusion

The present study allowed us to observe the diversity of medicinal plants used against viral diseases and sold on markets in the district of Abidjan in Côte d'Ivoire. *Ocimum gratissimum* appeared as the most used plant. Leaves are the most used organs for medicinal preparations which are mostly in the form of orally administered decoctate. This study highlights the essential role of traditional medicine in the treatment of viral diseases in Côte d'Ivoire. It suggests very important perspectives that should eventually allow the isolation and identification of new antiviral active principles.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there are no conflicts of interest related to this manuscript.

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