Vol. 15(1), pp. 10-32, January, 2021
DOI: 10.5897/AJPP2020.5170
Article Number: F651E3D65889
ISSN: 1996-0816

http://www.academicjournals.org/AJPP

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African Journal of Pharmacy and Pharmacology

Full Length Research Paper

Reflection on medicinal plants, especially antivirals and how to reconsider ethnobotany as an interesting way for health preservation

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Received 17 June 2020; Accepted 10 September, 2020

The medicinal plants, which are at the origin of the medical sciences, are gradually passing from the apothecary vials, from the handmade bags of the tradipraticians to the laboratories to provide countless new medicines synthesis models. Today, chemical drugs have replaced most herbal drugs in pharmacies. Empirical knowledge has been neglected as chemistry progressed. Yet 80% of the world's population is still being treated with plant-based medicines. Indeed, some parts of our earth still keep intact the medicinal knowledges, through tradition, culture and heritage preserved by the tradipraticians, who still practice all over the world. It is possible that in the face of the threat of epidemics, which are constantly putting us to the test, plant drugs are once again an important alternative to consider. Our article deals with 3 connected topics: an ethnobotanical survey (experimental result); the creation of a project model of ethnobotanical garden (experimental result); and a knowledge inventory on antiviral plants (bibliographical synthesis in the framework of scientific monitoring). There is a lot of knowledge that can be reinvested. Through some results of ethnobotanical surveys, an inventory of antiviral plants and the model of a project to set up ethnobotanical gardens in the city, re-appropriation of ethnobotanical knowledge will be shown to prove valuable for research and may be an alternative for the future for the preservation of the health of all.

Key words: Medicinal plants, antivirals activities, metabolites, ethnobotanical garden project, traditions.

INTRODUCTION

Since prehistoric times (-60,000 BC), plants and humans interact: Neanderthal burials found in Iraq show pollen grains presence in diuretic plants. At the time of the Cro-Magnon Man (-35,000 BC), traces of poppy crops were found (Girre, 1981).

In China, Emperor "Shen-Nong" or "Shennong" (also known as "Agriculture God") in -2800 BC, invented the medical material, 100 years before the «Pen Ts'ao»

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publication. This collection brings together all the known formulas of tablets and papyrus to the knowledge of the moment. It is in a way the first great medicinal and medical compilation (Houdret, 1999).

It was only in the twelfth century BC that superstition and magic, the Western therapeutics of the time, would be gradually replaced and/or enriched, thanks to the monks expelled from the east, by the heritage of the ancient Eastern civilizations (Sumerian, Egyptian, Chinese and Indian). Aristotle will write the treatise «*De Materia Medica*» which, with 519 medicinal plants, will be the reference collection used in the west until the middle ages. All this work will give rise to the western pharmacopoeias that now govern western therapies (Girre, 1981).

In the middle ages, in Europe, various prohibitions appeared against superstitions, alchemy and magic. The monks, on the other hand, had constantly continued despite all to maintain the medical traditions of antiquity by means of a garden «of the simple». In the 13th century, new apothecaries other than those practised in monasteries appeared. It is only in the 18th century that these will distinguish themselves from other food shops. In the 19th century, chemistry allowed the extraction, synthesis and/or hemisynthesis of many metabolites. These will give powerful active principles of medicines having either a natural origin (morphine, catharine, anthvindoline, digitaline, taxol, deacetylbaccatin 3), or a hemisynthetic origin (natural molecule transformation - vinblastine, vincamine (Bruneton, 2009).

MEDICINAL PLANTS AND THEIR METABOLITES

Plants play a very important role in many ecosystems, by fixing part of the light energy in the form of organic matter, thus constituting, directly or indirectly, the food source of many living beings. They also play a leading role in climate regulation through the fixation of atmospheric CO_2. They are therefore indispensable for the survival of most living beings and the human species is no exception. Although since the development of agriculture 10,000 years ago, they have been seen primarily as a source of food (Fernando, 2012), they have also been known for a long time for their medicinal properties.

A plant compensates for its immobility by the production of countless molecules since it is an autotrophic eukaryotic organism (except parasitic plants). Its power comes from this extraordinary ability to produce its own organic matter in parts of water, air, mineral salts and light. Thus, under its fragile air, the plant is a formidable chemical factory that can control its environment by means of the metabolites it produces.

Plants synthesize primary metabolites such as carbohydrates, lipids and proteins produced directly through photosynthesis that allow them to grow and develop (Chaouche, 2014). Plants also synthesize secondary metabolites that play, among other things, a role in their defense against external aggressions (Koné, 2009). It is these compounds that are at the origin of most of the properties of medicinal plants, but it is only from the XIXth century that research and isolation of active principles at origin of these properties begins (Muanda, 2010; Techer, 2014). Over 200,000 secondary metabolites of a wide variety of structures have already been identified (Koné, 2009; Muanda, 2010). Many structures are characteristic of a genus or species, so that the identification of these substances can sometimes be used to establish a chemo-taxonomic marking (Koné, 2009).

Yet it is estimated that less than 2% of existing plant species have been tested for their medicinal properties (Fernando, 2012). Secondary metabolites are tools for co-evolution between plants and surrounding living things. Metabolites, mainly secondary, have important physiological properties: these are often the active ingredients that will be used as a source and/or models for allopathic drugs (by means of hemisynthesis and synthesis) nowadays. But if we remember medicine history, it is easy to understand that this old empirical knowledge, although lost in industrialized societies, remains a living traditional medicine in nearly 80% of the world's population. This ancestral knowledge proves to be today really tedious to reconstruct because the tradition of oral transmission has been lost. A protocol described in a scientific article is sometimes impossible to repeat by another research team because it lacks direct contact with the one who implemented the protocol. Similarly, it is extremely difficult to find the way a medicinal drug is prepared. The detail is fundamental, as we find in the extreme precision in the preparation of Chinese drugs. Every detail is crucial. For example, the diterpenes characterisation of diterpenes by thin-layer chromatography, although relatively simple, remains almost impossible when one does not pay attention to the time it makes during the revelation to the Erlich reagent. Examples of this type are legions in research. This is why the loss of our knowledge in traditional medicine is critical and our work as an ethnobotanist phytochemist is urgent.

There are plants with alkaloids, often toxic nitrogen substances, used as powerful active ingredients in the manufacture of drugs, especially in the field of anticancer. Alkaloids provide protection against herbivores (Koné, 2009). The yew, periwinkle, belladonna, opium poppy, tobacco and many others are powerful natural arsenals that help humans heal (Muanda, 2010). They are particularly active in the nervous system, such as CNS depressants such as morphine and codeine, stimulants such as strychnine, ephedrine and caffeine, and local anesthetics such as cocaine. Many of them, endowed with low doses of marked pharmacological properties, are used as medicines: atropine and quinine (antimalarial), pilocarpine and vincristine (anticancer), caffeine

(stimulant), nicotine and strychnine (poisons). At inappropriate doses, they may cause symptoms such as heart rhythm disorders (depressant quinine), hypertension (ephedrine) and hypotension (yohimbine), dizziness, agitation, convulsions, vomiting, mental confusion, paralysis (ergotamine) and even coma. Their biological actions also place them at the heart of co-evolutionary phenomena of interactions (Bruneton, 2009; Rangari, 2009).

The other family of molecules is that of heterosides. These are compounds in which at least one sugar molecule is bound with oxygen to another non-osidic compound, often nitrogen, called genie. Depending on the nature of the genie, there are several categories of heterosides each with interesting potential. Cardiotoxic heterosides (with a lactone cycle) decrease the frequency of heart contractions. They are also surfactants. Although having therapeutic properties, their therapeutic and lethal doses are often very close, as for example the digitaline used against atherosclerosis. The heterosides anthracenes are laxative and purgative molecules found in buckthorn, Aloes, Rhubarb, Sene and Cascara.

There is also the category of glucosinolates which are sulphur heterosides, responsible for the strong odors and gouts characteristic of Brassicaceae. They are flavorings (acre taste). They can be goitrogens. They are also potent phagodeterrants and can also be anti-infectious and pulmonary fluidifiers (mucus), but also anticancer (cabbage, broccoli, Brussels sprouts). The saponosides having three types (steroidal, terpenic and/or alkaloid) are heterosides with bitter taste (gastric irritations), with tensio-active properties (foaming solutions used in antiquity and made from saponaire leaves) have many therapeutic activities: as hemolytic toxicity to cold-blooded animals, as antiviral (Licorice), as molluscicide, as anti-inflammatory (Horse Chestnut), as antitussive and expectorant (Ivy, Polygala and primrose), as analgesic (Platycodon), as protective hepaton (Ginseng) and as a sweetener (licorice). The jujube leaves saponosides cancel the perception of sweet taste. The last category of heterosides are mucilages in the form of indigestible fibrous gels that swell with water (agar agar), whose roles are to improve the functions of the intestines, promote cholesterol removal and soothe inflamed mucous membranes (Bruneton, 2009; Rangari, 2009; Koné, 2009).

Terpenes are a large and important family of secondary metabolites derived from the plant kingdom. They are polycyclic compound, usually lipophilic. The compound in C5 are hemiterpenes, those in C10 are monoterpenes which include essential oils, pyrethrins (insecticides) and iridoids (bacteriostatic, plant/insect signalling). The C15 are sesquiterpenes, at the basis of aromatherapy, where we find the Farnesol (perfumery) and the caryophyllène (pepper pungent taste). In therapy, they can have anti-inflammatory activities (matrix, arnica), antibacterial, antimalarial (essential oil of *Artemisia annua* L.), and antiseptic (thyme essential oil, clove, lavender, eucalyptus). Some molecules such as ketones (thuyones) and lactones can be nephrotoxic (Western Thuya, Officinal Hyssop, Odorous Aneth, and Officinal Sage). In France, Decree 86-778 of 23 June 1986 lays down the list of essential oils whose sale to the public is reserved for pharmacists, pursuant to Article L 512 of the Public Health Code. These are essential oils from absinthe, small absinthe, sagebrush, cedar, hyssop, sage, tanasia, thuya, etc. With 4 sub-units (C20), we have diterpenes including campestrol and campestrolone with antibilharzial properties (EL Babili et al, 1998, 2006, 2012). This group also includes tocopherol or vitamin E and phylloquinone or vitamin K1, and anthraquinone (Potent laxative effect). Triterpenes (C30) show heterosides (terpenic genin + sugar) and phytosterols (stigmasterol and sitosterol). Tetraterpenes (C40) include carotenoids such as photosynthetic pigments (beta-carotene) and lycopene (antioxidant). The C45 and C50 compound are ubiquinones and plastoquinones. Finally, there are polyterpenes in which we find rubber in the form of milky emulsion or latex.

Plants are also widely used for their phenols (Zakaryan et al., 2017). They are aromatic, nonnitrogen chemical compounds that carry a hydroxyl (OH) function, free or linked to another etheric, ester, and heteroside function. Derivatives with several hydroxyl functions are called polyphenols (e.g., lignin). They are of remarkable diversity, nearly 8000 compounds described, belonging to many families according to their chemical structure (Koné, 2009). It contains simple phenols whose therapeutic interest often concerns properties such as urinary antiseptic (arbutin), anti-inflammatory (salicylates of the Willow and the Queen of the near), enzymatic inhibitors of forsythia fruit (also used as antiallergic drugs in Traditional Chinese Medicine). Among these phenols, flavonoids also have interesting physiological roles as UV filters or powerful antioxidants. Lignin is often referred to as "inappetant" compounds. Tannins are water-soluble phenolic compounds precipitating with proteins that make tissues harder hence their waterproofing. They are tanning agents for leather animal skins. They have an astringent effect on salivary mucous membranes. They can help reduce diarrhea, bleeding and secretions. The phenolic compounds generally have antioxidant properties such as the phenols of Rosemary, flavonoids of Ginkgo; the anti-tumor properties of lignans of podophyl, phyto-oestrogenic properties of isoflavones of soya, antimicrobial properties of Lamiaceae rosmarinic acid, vanillin (vanillia), anethol (dill), eugenol (clove), antibacterial properties of tannins (Cranberry), antidepressant properties of St. John’s wort hyperforine, tetrahydrocannabinol (THC) cannabis (Bruneton, 2009; Rangari, 2009). The secondary metabolites described earlier and particularly the phenolic compounds perform a multitude of functions within the plant such as communication with its environment, its development and

its defense against various aggressions (Koné, 2009; Muanda, 2010).

Plants have their own mechanism of defense against pathogens or “basal defense” (Musidlak et al., 2017). These “basal defense” mechanisms acting on protein synthesis, such as resistance proteins or ribosome-inactivating protein (RIP), specifically block the pathogen, for example by preventing its protein synthesis (Musidlak et al., 2017).

All these metabolic data allow us to realize the immense wealth that the plant world offers for health.

A recent study from March (Khaerunnisa et al., 2020) shows that kaempferol, quercetin, luteolin-7-glucoside, demethoxy curcumin, naringenin, apigenin-7-glucoside, oleuropein, curcumin, catechin, and epicatechin-gallate were the most recommended compounds found in medicinal plants that may act as potential inhibitors of COVID-19 main protease.

Another Chinese study from February 2020 (Luo et al., 2020) highlights the interest in the control of COVID-19 in Traditional Chinese Medicine by the following plants: *Radix astragali* (Huangqi), *Radix glycyrrhizae* (Gancao), *Radix saposhnikoviae* (Fangfeng), Rhizoma Atractylodis Macrocephalae (Baizhu), *Lonicerae japonicae Flos* (Jinyinhua), and *Fructus Forsythia* (Lianqiao). However, further research is necessary to investigate the potential uses of the medicinal plants containing these compounds.

In France, Professor Raoult’s team proposes as a therapeutic way, in a hospital in Marseille, hydroxychloroquine combined with an antibiotic, azithromycin. Hydroxychloroquine is a nitrogen metabolite that would significantly reduce viral load in patients with COVID-19. This chloroquine analogue would be quite effective when administered in the presence of the antibiotic azithromycin (Gautret et al., 2020). Once again, man finds help in nature. This antimalarial drug is first discovered and extracted from Quinquina before becoming a valuable model for allopathy.

All these uses, despite their results, were not enough to safeguard the use of traditional medicine in rich countries, especially in the West. It is true that often the therapeutic actions of alkaloids, terpenoids are highlighted in «*in vitro*» experiments. *In vivo*, the work is more difficult and longer to complete. The reason is very simple, we no longer know how our ancestors lived and did to heal themselves. People who use traditional medicine today are doing relatively well, except when poverty and pollution are involved. Anthropological data are very little taken into account in the *in vivo* tests and the result is an inconsistency between the conclusive results *in vitro* and their often-inconclusive *in vivo* counterparts.

In phytochemistry, the systematic use of organic solvents has long allowed us to broaden our knowledge of plant chemical compositions. However, the type of extract studied never resembled those actually used by traditional medicines. Metabolomics, a medical science in the study of metabolites as a whole, has naturally established itself today in the field of phytochemistry. This science makes it possible to carry out a study of the plant chemical composition more in line with the native state, since the metabolites can be characterized in the extract without being totally isolated and thus eliminating the risk of degradation, among other things. Although intelligent, the human has essentially benefited from the ingenuity of nature to meet its needs. This description of the large families of biologically active metabolites makes it possible to measure the magnitude of the richness of the plant world. In the past, man has had inexhaustible resources to heal himself. He learned by observing his environment to use the plant world to heal himself. This resource is always available and ready to be reinvested otherwise through research. Regarding this last theme, an educational approach in an ecological and responsible project can be easily implemented. Today, botanical gardens remain reserved structures, almost exclusively for enthusiasts». The botanical gardens (especially those of the monasteries) although having been the source structures on which the apothecaries had relied to create their drugging, there is no prohibition against taking back this type of place in order to make it possible for everyone to recognize the plants that make up their environment since it is known that more than a quarter of the medicines come directly from the plants (Muanda, 2010; Fernando, 2012).

Many plant metabolites have remarkable biological properties that humans have gradually learned, first empirically to use in traditional medicine. The subsequent phytochemical scientific studies have now enriched our knowledge of plant constituents, in particular by highlighting the relationship between biological structure and activity. Table 1 illustrates this with the most remarkable examples.

Since then, scientists have continued to enrich and compile knowledge in order to achieve the pharmacopoeias (collection of mandatory and enforceable standards) that today govern scientific and therapeutic practice around medicinal plants, in particular. The African continent benefits from more or less sophisticated Pharmacopoeias in their formalization. However, their practice is still very lively and rich because the tradipraticians still exercise very actively both in the cities and in the villages (Bellakhadar, 1997). Allopathic drugs remaining out of reach of the populations have made the preservation of traditional medicine possible. Admittedly, the comfort of allopathy is attractive, but there are several limits (problems of tolerance, annoying side effect, addiction, inefficiency in the face of new pathologies). Epidemics consistently demonstrate this. It seems more necessary today than yesterday to safeguard the precious empirical knowledge, powerfully effective since they helped Man to cross the ages until today.

Table 1. Description of some known activities of secondary metabolites in the human body (Koné, 2009; Muanda, 2010; Chaouche, 2014).

Activity within the human body	Compounds family
Anti inflammatory	Tannins, flavonoids, lignans, coumarin, saponins
Antiparasitic	Phenolic acids, flavonoids, coumarin
Antifungal	Condensed tannins, phenolic acids
Anti-cancer	Flavonoids, coumarin, alkaloids
Anti atherogenic	Flavonoids
Analgesic	Flavonoids, coumarin, lignans, saponins, alkaloïds
Antibacterial	Flavonoids, phenolic acids, hydrolysable tanins
Antioxydant	Terpenes, tannins, anthocyanins, flavonoids, phenolic acids
Antiviral	Alkaloids, anthocyanins and coumarin (Mohammadi et al., 2019), flavonoids, terpenes, lignins, steroids, tannins (Zakaryan et al., 2017)

Despite advances in modern medicine, many diseases still cause serious problems. The proposed treatments are difficult to access because they are too expensive for a large part of the world's population (Koné, 2009). Examples include skin diseases with effective antibiotic and antifungal remedies, but unfortunately still inaccessible to a segment of the population (Asong et al., 2019). Another example, gastroduodenal ulcer affects about 10% of the world's population (Togola et al, 2014). In other cases, the treatments are not very effective and often accompanied by more or less serious side effects. This is particularly true of viral diseases (Mukherjee, 2019), but also chronic diseases, which, according to the WHO, are the leading cause of death in the world.

In this time of pandemic, it is important to dive back into the collective and empirical memories that would allow us to fight viruses. The latest WHO resolution "Traditional Medicine Strategy 2014-2023" called for the return of traditional medicines to the universal health system (OMS , 2013). Colonization had allowed the enrichment of knowledge in traditional medicine until the time when chemistry was privileged. So herbal medicine, no longer had a real place in our care system. Since the entry into force on 12 October 2014 of the Nagoya Protocol, an international agreement on biodiversity, ancestral knowledge is once again protected and knowledge sharing is increasingly equitable (CDB, 2010).

A plant, although still shows ingenious mobility. Through its metabolites, the plant is extremely active, even powerfully active.

It should be borne in mind that, at present, plants are still the main reservoir of new drugs. The abandonment of traditional medicines for the benefit of conventional medicine has certainly had the advantage of creating a chemical pharmacy through allopathy but has put aside empirical knowledge.

This work focuses on traditional medicine through 3 related themes that are ethnobotanic through the very informative results of our recent surveys. The other aspect addressed is the place of ethnobotany in everyday life, a theme that we have chosen to address by creating a model type of ethnobotanical garden that could become a general framework easily usable everywhere. Finally, we will conclude this work with a work of bibliographical synthesis in order to establish a kind of inventory of knowledge on antiviral plants, particularly in the context of the global pandemic that is still raging, although the general containment is gradually giving up for now. This will allow us to see that a lot of knowledge exists and can be reinvested. Through some results of ethnobotanical surveys, an inventory of antiviral plants and the model of a project to create ethnobotanical gardens in the «city», we will show that a reappropriation of ethnobotanical knowledge will prove valuable for research and could be an alternative for the future for the preservation of the health of all.

MATERIALS AND METHODS

Scientific watch on antiviral plants

The data on medicinal plants was retrieved and downloaded using different search engines, including Web of Science, PubMed, Google Scholar and Scopus during the period March 16 to June 2020. The present review includes only articles that meet the required quality standards. Moreover, only those medicinal plants that are active against viruses were selected. Different keywords were used for the data search, including «plants and virus». Data are analyzed and then summarized in Table 4.

Ethnobotanic surveys on plants used during the COVID 19 pandemic

For ethnobotanical research, interviews were conducted by telephone and through the whatsApp application, with the network of known informants with whom we had previously worked in 2017 and 2019. So despite the confinement imposed almost everywhere

in the world, we were able to conduct our investigations. The “semi-directional” interviews allowed us to gather testimony on specific topics and the “directional” interviews were essential to verify information and communicate in local dialects. For interviews in Mooré and Arabic, the interviews were conducted in simple language, thanks to native speakers who have kindly adapted to our beginner language level. Research conditions are special but there were remote field feasibility because we already had a number of research materials collected *in situ* in observation, direct and/or participants, during our previous stays. We therefore defined our research at the borders of Essaouira province (Morocco), the village of Tanlili (Burkina Faso) and Gers department (France). Our joint research focuses on plants and their uses and thus the transmission of this knowledge of the nature that takes place there.

To carry out this long and complex work, we set off on an Excel spreadsheet in which we compiled more than 10 000 plants spread all over the world and presenting known traditional medicinal uses. A work of data processing allowed us by overlapping to select the most remarkable plants. From this list we conducted a literature search on each of the plants in the list, in order to gather the current state of knowledge on the topic of "antiviral activity". The interlinked data enabled us to highlight the plants listed in Table 5. These results show that despite the great richness of the plant world, little in-depth work is available.

It was noted that this research is still ongoing and that the first results are delivered here. The rest of the work and the transmission of knowledge aspect will soon be published.

Medicinal garden project

Finally, as for medicinal garden project model, being specialized in medicinal plants and their uses, we used our long experience to imagine this project, during two years. The model was developed with the specific advice of a medical colleague Daniel Charlot, specialist in medicinal plants as an expert at the ANSM drug agency in France. The work was carried out taking into account the global flora (the broadest possible research) in order to be able to give a model that gives place to any type of environment (arid, tropical, temperate, etc). The objective of our model is to make it “an adaptable model”. The chosen areas of activity represent the main pathologies for which we found data in the various pharmacopoeias consulted. The tools used are indeed various pharmacopoeias, including the European, Chinese, Moroccan, Ayurvedic, German, among others.

ETHNOBOTANICAL PANDEMIC INVESTIGATIONS: COVID 19 (DUE TO SARS-COV-2 VIRUS)

In December 2019, the Chinese authorities declare the appearance of a new disease Covid 19 (due to the SARS-Cov-2 virus) whose epicenter is located in Wuhan (central China). The virus is spreading in Europe and soon on all five continents. On 11 March 2020, the WHO declared the COVID-19 coronavirus epidemic a pandemic (OMS, 2020). An ethnobotanical study is then conducted, during the months of March, April and May 2020, in three areas of the world: Burkina Faso, Morocco and France. As for our research, it is still ongoing. First results were presented in this article, but you can find in our next one in progress all the anthropological details of the research.

Antiviral plants used for prevention in Tanlili Mossis (Saponé Department, Burkina Faso)

First two cases of Covid 19 are confirmed on 9 March 2020 in Ouagadougou (capital of Burkina Faso) by Mrs Claudine Lougué (Minister of Health) (VOA, 2020; Atcha, 2020). In parallel, measures are adopted by the Burkinabe Government to fight the pandemic of Covid 19 (SARS-Cov-2) (Santé Gouv, 2020). Between the end of February and the beginning of March 2020, religious authorities (including El Hadj of Ghana), marabouts and healers delivered «health recipes» to the population. The Burkinabe Council of Healers begins to be relayed from the beginning of March 2020 by the Burkinabe who have consulted their healers. The healers of Burkina Faso advise to consume the traditional anti-malarial tea to strengthen the body because the coronavirus has the same symptoms as malaria. A pot must be consumed every day in every family.” On the other hand, the information circulating in Burkina Faso in mooré on FM radio encourages the consumption of traditional preparations like Dolo (local beer) for exemple. Finally, we see that in Burkina Faso, some main recipes circulate: garlic crushed in fresh milk, «anti-palludic tea or antimalarial herbal tea» and the strengthening of the daily use of «Dolo» (almost daily food recipe). At Tanlili, 11 plants were used based on the survey results (Table 2).

Le Dolo

Some prevention measures are adopted by villagers such as local red sorghum drink use, “Le Dolo”. The religious authorities strongly recommended it, even for Muslims, during pandemic time (Afrikmag, 2020). In Mooré, it is explained that «*Dolo is used to treat the lung. So drink it. Even if you have the corona, it will be less serious*» (Mahunon et al, 2020). In Burkina Faso, Dolo is widely produced throughout the country. It is the most important fermented beverage consumed, and 40% of sorghum grains produced in Burkina Faso is used for its production (Sawadogo et al., 2007). Among the red varieties, those used for local beer ("Dolo") have a high content of phenolic compounds, known for their many biological properties (Dicko et al., 2002).

The antimalarial herbal tea

It is a drink usually consumed during previous epidemics. It is consumed for three days every seven days during an epidemic. In Tanlili, we use six out of eight of the plants of the recipe that can be found in the village or in the forest. *Mitragyna inermis* (Willd.) Kuntze (Rubiaceae) roots can be replaced or added to *Guiera senegalensis* J.F.Gmel. (Combretaceae) leaves. The leaves of *Diospyros mespiliformis* Hochst. ex A.DC. (Ebenaceae) can be replaced or added to the roots of *Ceiba pentandra*

Table 2. Summary of antiviral plants used in prevention to control Covid19 in Tanlili Mossis (Saponé Department, Burkina Faso).

Latin name/Binominal name	French name	Name moore [transcript phonetic]	Part used	Mode of administration/Uses
Mangifera indica L. Anacardiaceae	Manguier	[mangui]	Buds	Oral Route (OR)/ Drink (Dr)/Tea(T)
Carica papaya L. Caricaceae	Papayer	[papaï]	Leaves	OR/Dr/T
Eucalyptus globulus Labill. Myrtaceae	Eucalyptus	[ekaliptis]	Leaves	OR/Dr/T Antimalarial herbal tea
Azadirachta indica A. Juss. Meliaceae	Margousier	[niémier - nim]	Leaves	OR/Dr/T-Antimalarial herbal tea
Diospyros mespiliformis Hochst. ex A. DC. Ebenaceae	Ebénier De L'ouest Africain	[gâaka] [ganka]	Leaves	OR/Dr/T Antimalarial herbal tea
Mitragyna inermis (Willd.) Kuntze Rubiaceae	Osier Africain	[yilga]	Roots	OR/Dr/T Antimalarial herbal tea
Ceiba pentandra (L.) Gaertn. Bombacaceae	Fromager	[gounga]	Roots	OR/Dr/T Antimalarial herbal tea
Guiera senegalensis J.F.Gmel. Combretaceae	Guiera Du Sénégal/ Bambara	[wilinwiga]	Leaves	OR/Dr/T Antimalarial herbal tea
Sorghum bicolor (L.) Moench Poaceae	Sorgho Rouge	[kazeega]	Seed	OR/Dr/T - Dolo beer
Allium sativum L. Alliaceae	Ail	[albasle] [aïl]	Bulbs	OR - Culinary preparation (tô)
Allium cepa L. Alliaceae	Oignon	[guéba]	Bulbs	OR Culinary preparation (tô)

(L.) Gaertn. (Bombacaceae). The drug amount is measured by a small ball slightly larger than the wrist, per plant. It is possible to put two or three handles depending on water amount. In Tanlili, mango trees, daisies, eucalyptus and cabinetmakers from West Africa are present in the village. The other plants are in the forest, located 1 km from the village. The tea is composed of *Mitragyna inermis* roots, *Guiera senegalensis* leaves, *Ceiba pentandra* roots, *Carica papaya* leaves, *D. mespiliformis* leaves, *Mangifera indica* buds, *Azadirachta indica* leaves and *Eucalyptus globulus*. The tea is in fact a decoction, therefore a hot extraction of the metabolites by boiling water for 1 to 2 h.

Antiviral plants used for prevention in Gascons of Lectoure (Gers Department, region Occitanie, France)

According to the results of interviews with informants interviewed on the use of plants to prevent or control coronavirus, 7 plants were used in the gers according to the results of the survey conducted (Table 3).

Antiviral plants used for prevention in Souiri (inhabitants of the province of Essaouira) in Morocco

Based on interviews with informants interviewed about the use of plants to prevent or control coronavirus, 12 medicinal plants were cited (Table 4).

By analysing and cross-referencing data, 24 of the 53 plants studied, according to our ethnobotanical study, are still used traditionally, actively and especially during the pandemic of COVID19.

Our bibliographic research shows that alliums are active against HIV, herpes simplex virus and IBV coronavirus. *A. indica* would be interesting against the hepatitis C virus. *C. papaya* and *Ceiba pentandra* would be active against the Dengue virus. *D. mespiliformis*, *M. indica*, *Mentha* × *piperita, Momordica charantia* and thymus show encouraging early results in the fight against HIV. It emerges that often plant extracts, through their metabolites, will help the immune system by fighting against viruses, especially HIV, which weakens the immune system and prevents our body from manufacturing the antibodies necessary for the preservation of health. The traditional indications are often "strengthen the body", especially in Africa. There is some correspondence that could be corroborated by further investigation of the empirical knowledge of traditional medicine.

Place of ethnobotanical collections in the city

In France, although medicinal plants are under a pharmaceutical monopoly, unlike many other countries in the world, the number of drugs released continues to increase. In Europe, different countries sell medicinal drugs freely.

Table 3. Summary of antiviral plants, used in prevention to fight against Covid19, in Lectoure Gascons (Gers department, Occitanie region, France).

Latin name/Binominal name	French name	Name moore [transcript phonetic]	Part used	Mode of administration/Uses
Allium sativum L. Alliaceae	ail	[alh]	Bulbs	OR Culinary preparation
Allium cepa L. Alliaceae	oignon	[ceba]	Bulbs	OR Culinary preparation
Citrus medica var. limon L. Rutaceae	citronnier	[limon]	Fruit	OR/Vaporization
Thymus vulgaris L. Lamiaceae	thym	[branon]	leaves	OR/Dr/infusion
Lavandula spica L. Lamiaceae	lavande	[aspic]	Essential oils	OR/Vaporization
Melaleuca quinquenervia (Cav.) S.T.Blake - Myrtaceae	niaouli	Not originating in the region therefore no name in Gascon	Essentials oils	OR/Vaporization
Cinnamomum camphora (L.) J.Presl, Lauraceae	camphrier de Chine	Not originating in the region therefore no name in Gascon	Ravintsara essentials oils	OR/Vaporization

Table 4. Summary of antiviral plants used in prevention to control Covid19 in Souiri (province of Essaouira, Morocco).

Latin name	**French name**	**Arabic name [phonetic transcription]**	**Part of the plant used**	**Mode of administration/Uses**
Allium sativum L. Alliaceae	ail	[touma]	Buds	OR/Dr/T Culinary preparation
Allium cepa L. Alliaceae	oignon	[bassal]	Buds	OR/Culinary preparation
Artemisia herba-alba Asso Asteraceae	armoise	[chih]	Leaves	OR/Dr/T
Trigonella foenum-graecum L. Fabaceae	fenugrec	[halba]	Seeds	OR/Dr/T/Culinary preparation
Syzygium aromaticum (L.) Merr. & L.M.Perry, Myrtaceae	clou de girofle	[kronfal]	Floral buds	OR/Dr/T
Thymus vulgaris L. Lamiaceae	thym	[zaatar]	Leaves	OR/Dr/T
Eucalyptus globulus Labill. Myrtaceae	eucalyptus	[caliptus], [kreïtus]	Leaves	Fumigation/Vaporization in Homes
Tetraclinis articulata Mast. Cupressaceae	thuya	[arrar]	Leaves	Fumigation/Vaporization in Homes
Origanum compactum L. Lamiaceae	origan	[tawabul]	Leaves	OR/Dr/T
Lavandula stoechas L. Lamiaceae	lavande	[lkhzama]	Leaves/ Floral Buds	OR/Dr/T
Mentha x piperita L. Lamiaceae	menthe poivrée	[naana]	Leaves	OR/Dr/T
Citrus medica var. limon L. Rutaceae	citronnier	[lemon]	Fruits	OR/Dr/T Culinary preparation

There is therefore almost no obstacle left to the fact that the medicinal tradition is becoming more and more popular, in order to allow everyone to relearn how to recognize the medicinal plants that surround them. Of course, there is still a giant step to be taken in this process, because a drug must absolutely not be used in any way. One only has to look through a pharmacopoeia to see that the indications are very precise, especially in ancient pharmacopoeias and always used as the Chinese, Ayurvedic and most pharmacopoeias of Africa. Phytotherapy, due to regulation and training channels, is still underdeveloped. The great disparity in regulatory affairs around the world illustrates the difficulties that explain the loss of tradition. Putting in place a “garden of the simple” in each city would be a first step in this direction. Initially, medicinal plants formerly called «the simple» were cultivated in the gardens of the monasteries. Great care was taken to their organization. Moreover, it is still possible to discover them in some villages like «The garden of herbs at the Garde-Adhémar». To feed this idea, a medicinal plant garden project aimed at

Figure 1. Ethnobotanical garden project: general presentation.

enhancing an ethnobotanical collection could be created, in each city, according to different models. In France, there is the spiral model as in the Henri Gaussen botanical garden, the thematic squares as in the herb garden of the Garde Adhémar, the flat strips as in the Pau garden «Conservatoire des Légumes Anciens du Béarn called CLAP». Medicinal plants will be distributed according to their medicinal properties and uses recognized by pharmacopoeias and/or advances in scientific research. A model can be set up according to the model we imagined (Figure 1) for a spiral garden but which can easily be adapted in the form of skillfully arranged squares. The plants can be divided into spheres of activity (Figure 2) such as the urinary, digestive, respiratory, genital, and cutaneous and nervous system. There may also be plants with magical uses since beyond the cultural social aspect; there is pharmacology that supports some of the uses as with psychotropic plants. Toxic plants have also always been of vital importance because they have been and remain valuable sources of active substances. Finally animals domesticated by man have, are and often remain cared for like humans by plants. Figures 1 and 2 present the model of an ethnobotanical garden project.

Medicinal plants (MP) offer a huge reservoir of active substances. These allow fighting against a large number of pathologies or diseases (D) and will be illustrated each by the appropriate board: Figures 3 to 15 (Spheres of medicinal activities).

MEDICINAL PLANTS USED IN TRADITIONAL MEDICINE TO FIGHT AGAINST VIRUSES

Viruses are the cause of violent epidemics with very high mortality rate (Mohammadi et al., 2019; Mukherjee, 2019). In this regard, we can mention the chikungunya virus epidemic (between 2005 and 2011) that infected 1.3 million people in India (Techer, 2014) and of course the VANOC-19 pandemic, which is unprecedented. The fight against viruses is through vaccine research. In addition to vaccines, the means of controlling viruses also include the use of so-called “antiviral” substances. The latter will make it possible to block at least one stage of the viral

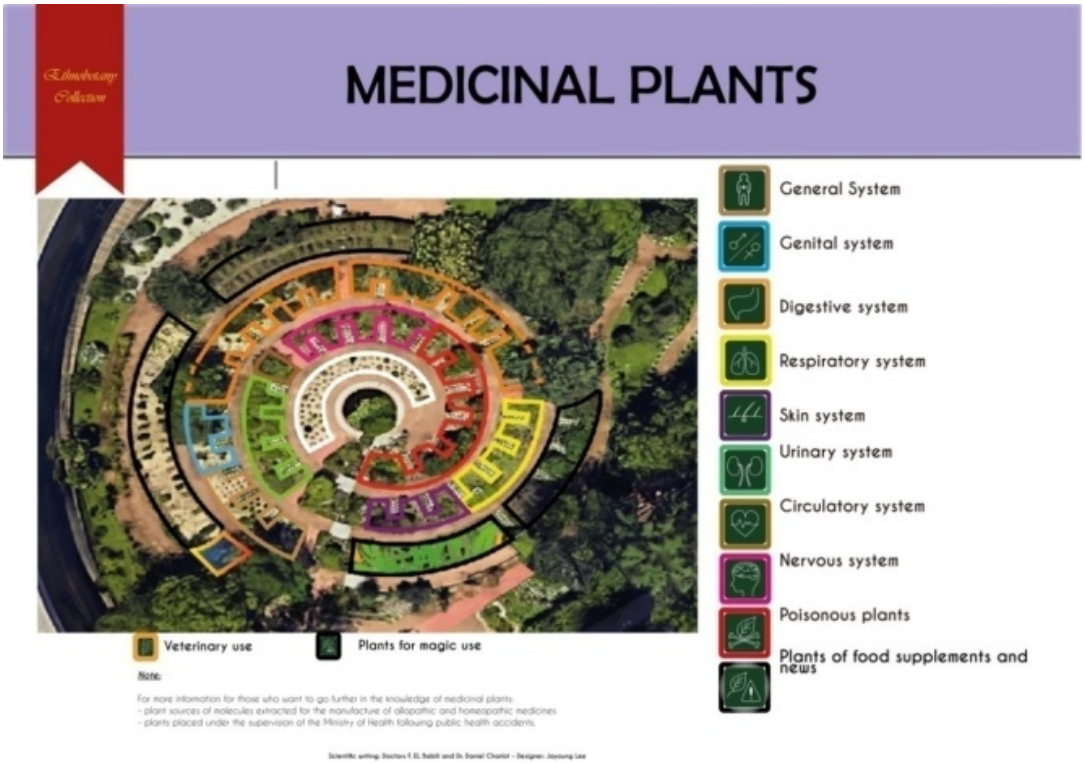

Figure 2. Different activity spheres of an ethnobotanical garden: spiral model example.

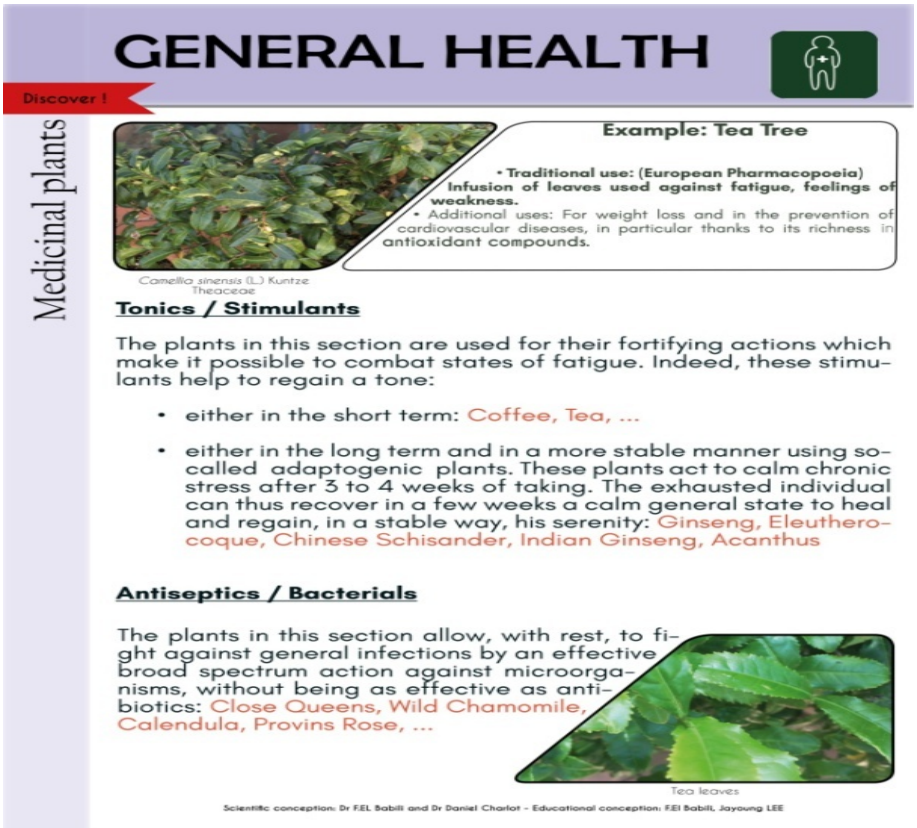

Figure 3. MP for general health.

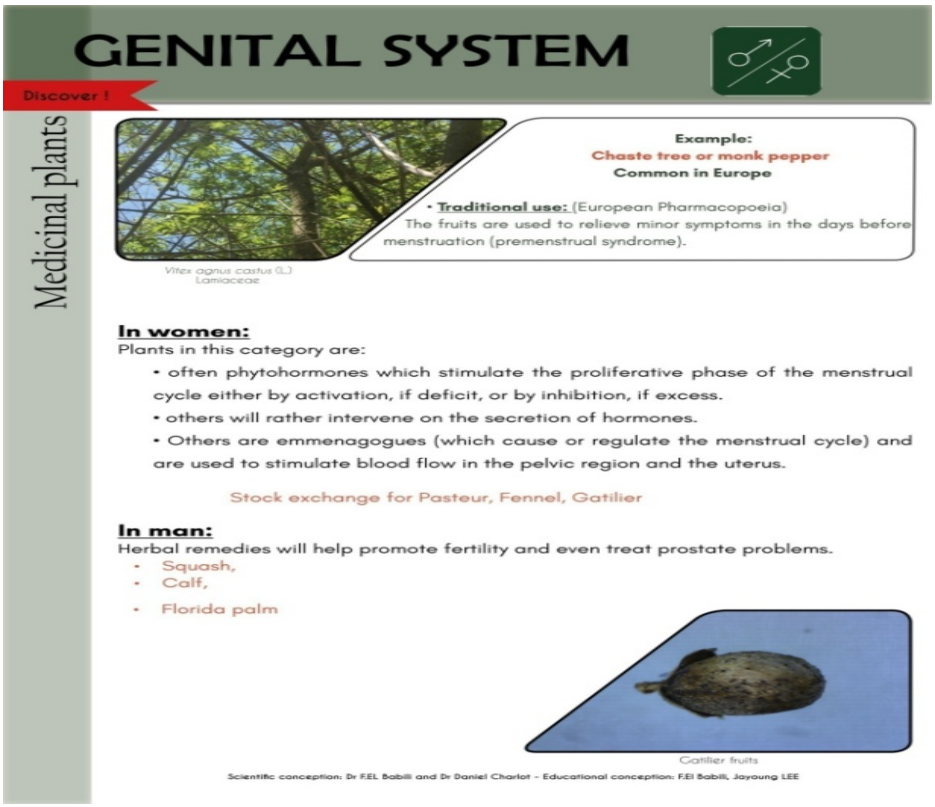

Figure 4. MP for genital D.

Figure 5. MP for digestive D.

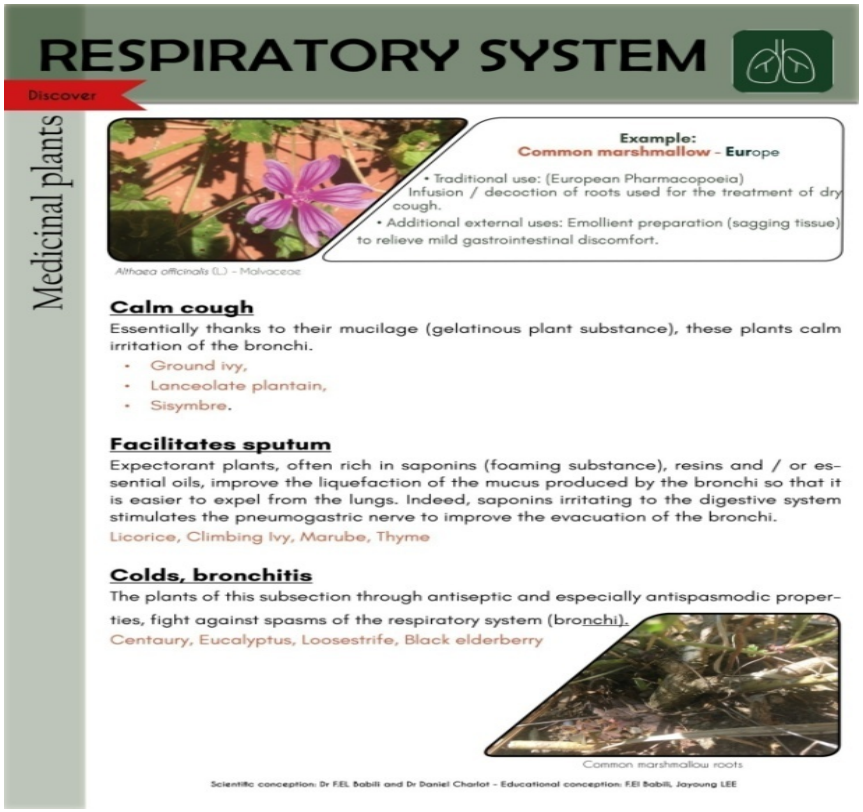

Figure 6. MP for respiratory D.

Figure 7. MP for skin D.

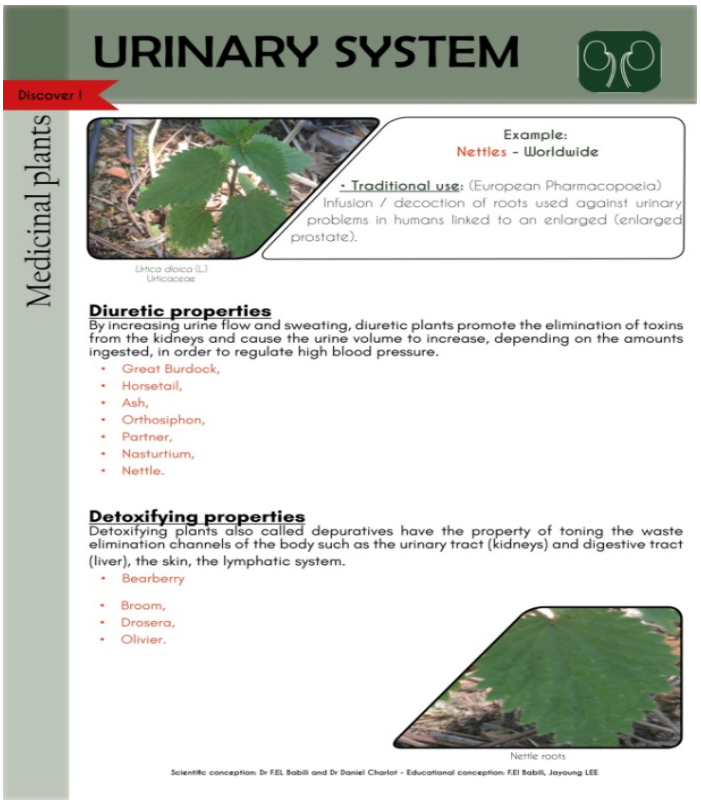

Figure 8. MP for urinary D.

Figure 10. MP for nervous D.

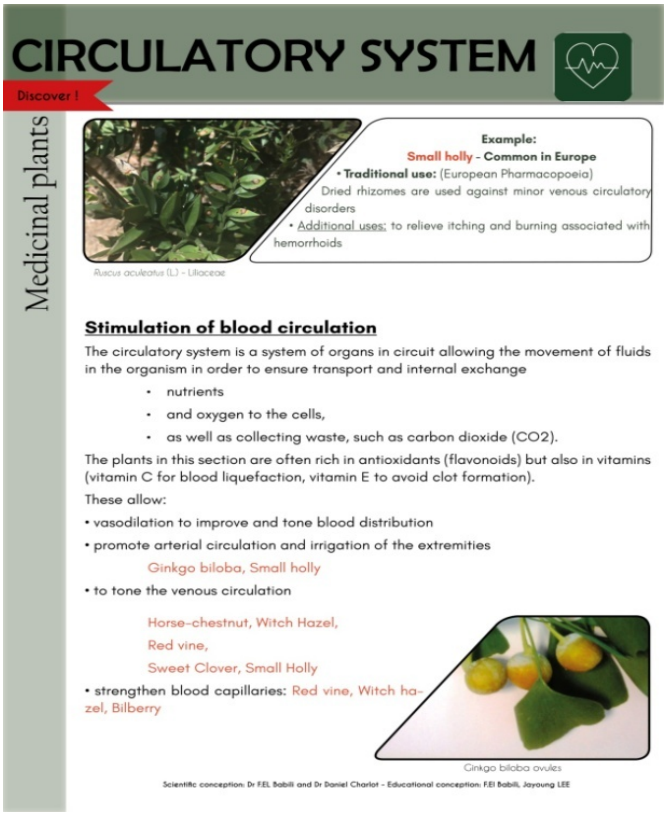

Figure 9. MP for circulatory D.

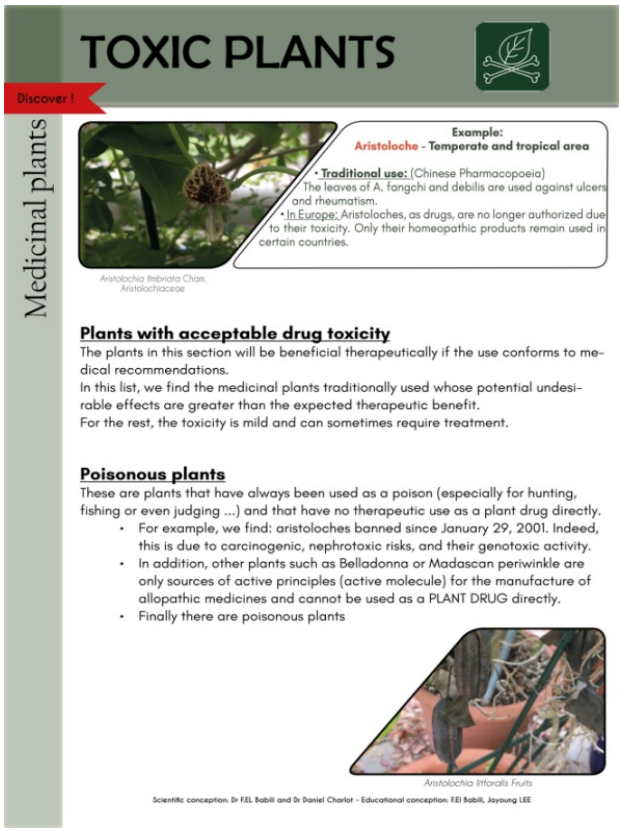

Figure 11. Poisonous plants.

Figure 12. MP under surveillance .

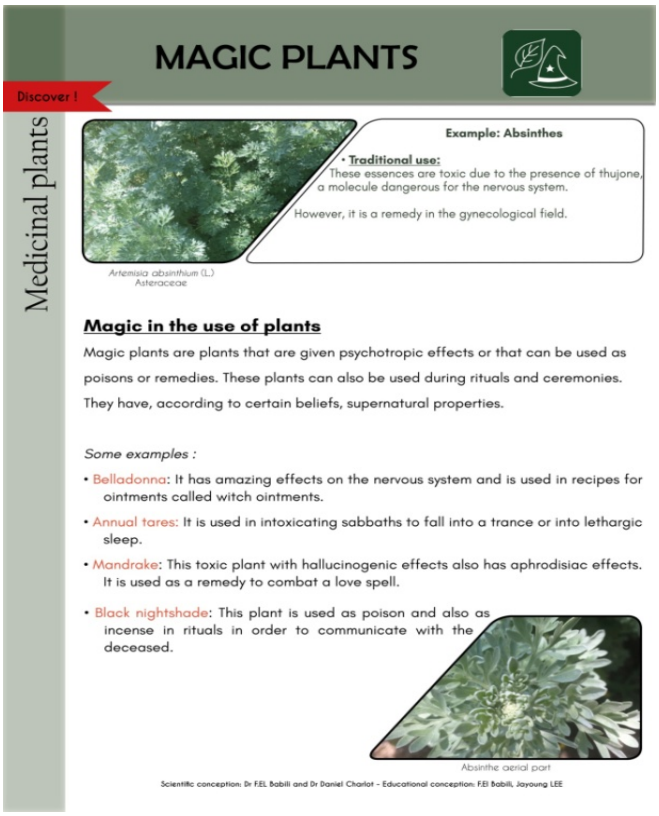

Figure 14. Magic plants.

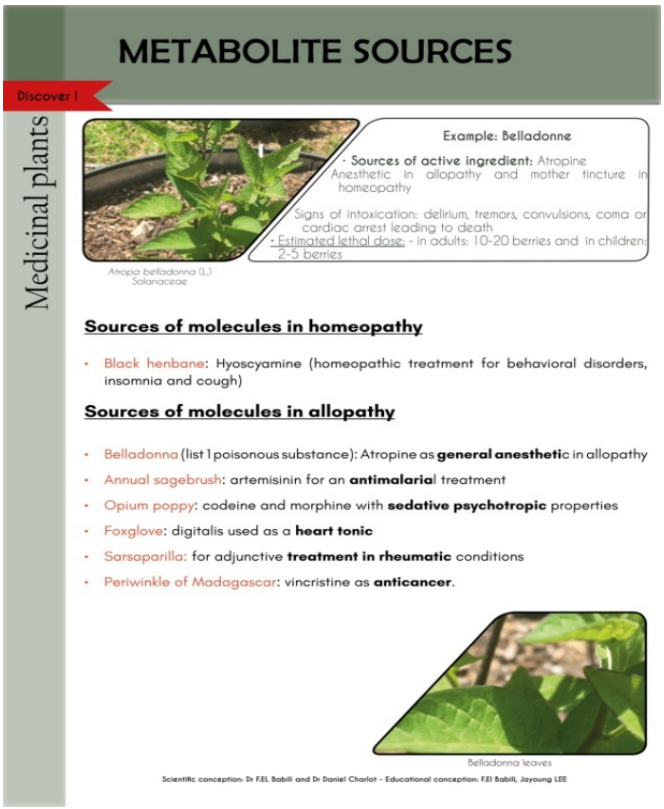

Figure 13. MP as bioactives compound for medicine.

Figure 15. MP for veterinary use.

cycle, by targeting and inhibiting a viral protein essential for the completion of its cycle. An example of HIV control is the Highly Active Antiretroviral Therapy (HAART) method, which uses a combination of compounds to inhibit both reverse transcriptase and protease, with the aim of blocking nucleic acid synthesis, respectively, and the synthesis of new viruses (Mohammadi et al., 2019). There are also methods that target cellular proteins that will help spread the virus (Mohammadi et al., 2019). It is in this case that some secondary plant metabolites are able to inhibit one or more proteins of the cycle and thus constitute a means of control against them. For example, it was not until 1938 that the role of flavonoids contained in lemon bark was highlighted in the fight against scurvy (Zakaryan et al., 2017).

More than 2500 plants have natural antiviral substances with a broad spectrum of action and low toxicity to the body (Zakaryan et al., 2017; Mukherjee, 2019). Given the diversity of existing compounds (Mohammadi et al, 2019), it is understood that these secondary metabolites are an arsenal of choices in antiviral control. The world flora therefore constitutes an almost inexhaustible reservoir of natural bioactive substances (Muanda, 2010). In the face of the growing viral threat that represents, more than ever with the epidemic of COVID-19, a major global health issue, the search for natural substances capable of fighting viruses and their symptoms, by blocking a stage of the viral cycle, by stimulating the body's immune defenses, is more than topical.

In Madagascar, there is a lush flora that is the source of many drugs with powerful biological activities, today also recognized in conventional medicine, such as *Catharanthus roseus* (powerful anticancer) and *Artemisia annua* (antipalludean). Against the herpes virus the Malagasy tradipraticians use the roots and leaves of *Rhinacanthus osmospermus* Boj. (Acanthaceae), the leaves of *Helichrysum gymnocephalum* (DC) Humb. (Asteraceae) and the leaves of *Jatropha curcas* L. (Euphorbiaceae). Against measles, the Asteraceae *Vernonia appendiculata* Less. and *Senecio erechtitoides* Bak. are used as well as the Myrsinaceae *Maesa lanceolata*. Smallpox due to the varicella zoster virus, is treated with *Vernonia appendiculata* Less. (Asteraceae) and *Maesa lanceolata* (Myrsinaceae). Finally, for rabies, four plants, three of which are well known in France, are used as *Solanum nigrum* L. (Solanaceae), *Curcuma longa* L. (Zingiberaceae), *Phytolacca dodecandra* L. (Phytolaccaceae) and *Cnestis polyphylla* Lamk. (Connaracées (Pernet and Meyer, 1957).

In Africa, *Citrus medica* is used against the flu. In Cameroon *Ancistrocladus korupensis* Dev. is an antiviral especially against HIV ((Boyd et al, 1994; Hallock et al., 1998). Henna leaves (*Lawsonia inermis* Lythraceae) are used in traditional African medicine to control polio and measles. *Brocchia cinerea* (del.) vis. Asteraceae, endemic to the Moroccan Sahara is used against respiratory infections as well as *Cucurbita lagenaria* (Bellakhadar, 1997). *Ajuga iva* (lamiaceae) is a panacea drug in Morocco. *Nigella sativa* or sânuj is used in Morocco as a seed decoction against influenza caused by the Influenzae virus (Bellakhadar, 1997). *Zizyphus lotus* L. (rhamnaceae) fruits are traditionally used to treat measles in Morocco.

Thus a series of antiviral plants are used all over the world: *Capsicum annuum* (Solanaceae) stem bark against Hepatitis, *Allium sativa* (Lilacaee Garlic) Bulb against Poliomylitis, *Zinger officinale* Ginger Rhizome against Poliomylitis, Measles, Jaundice and Yellow fever, *Vernonia amygdalina* (Asteraceae) leaves against Measles and Jaundice, *Anacardium occidentale* (Anacardiaceae) leaves, stem bark against Jaundice, *Manihot esculata* (Euphorbiaceae) leaves against Jaundice, *Bambusa vulgaris* (Poaceae) leaves against Measles, *C. papaya* (Caricaceae) leaves against Poliomylitis, *Magnifera indica* (Anacardaceae) stem bark against Jaundice and Yellow fever, *A. indica* (Melcaceae) stem bark against Jaundice, *Senna occidentalis* (Fabaceae) leaves against Measles, *Morinda lucida* (Rubiaceae) roots against Yellow fever (Oladunmoye and Kehinde, 2011).

Valnet reports that *Aconitum napellus* and *Saponaria officinalis* are two drugs formerly used to control shingles caused by the varicella zoster virus (Valnet, 1976). *Borago officinalis* is used in Europe to promote skin rash during measles as well as odorous asperus, poppy, large daisy, black elder, and tussilage. Against the flu an arsenal of drugs existed in France in which were found garlic, alder, borage, white broth, cinnamon, capillary, small centaury, fennel, lavender, ivy, onion, pine, primrose, sage, borer, black elder, tussilage and our famous violet (Valnet, 1976).

In India, ayurvedic pharmacopoeia, ancient and very rich, offers more than twenty drugs with antiviral properties empirically demonstrated and having given place to research to confirm, see find the type of bioactive metabolites (Williamson, 2002). Phytochemical research is very active and very encouraging. It seems that limiting oneself to allopathic medicine is a handicap when one observes the rest of the world or traditional medicine to last. Limiting health protection only through allopathy and inherent financial constraints is a serious mistake. Nearly 80% of the world's population is deprived of it because it is financially and socially inaccessible. It is in a reasonable observation, far from any individualism and supremacy, that the solution can be found. A traditional remedy is always cheaper than an allopathic drug and is often just as effective, if tempted that the empirical data have not been lost.

Already in 2004, McCutcheon et al. (2004) work showed the anti-coronavirus activity of different plant extracts. Thus the alcoholic extracts of 2 rosaceae, *Rosa nutkana* and *Amelanchier alnifolia* were very active against enteric coronavirus. In addition, the root extract of *Potentilla arguta*, had completely inhibited this respiratory syncytial virus, as well as *Sambucus racemosa*.

The 2019 coronavirus pandemic (COVID-19) is caused

by SARS-Cov-2 (severe respiratory syndrome). The viral enzyme 3-chymotrypsine-like cysteine protease (3CLpro) controls the replication of this coronavirus and is essential for its life cycle. A screening of 32,297 traditional Chinese medicinal plants was conducted to isolate potential antiviral medicinal compounds. *Toona sinensis* Roem tender leaf extract inhibits SARS coronavirus replication (Chen et al., 2008). The UI results (research team) were thus able to highlight nine first potential anti-SRAS-Cov-2 results that could lead to the development of drugs to fight COVID-19 disease (Ul et al, 2020).

Since the onset of coronavirus disease 2019 (COVID-19), which was first reported in Wuhan, China on December 31, 2019, 1,830 trials have been documented by the WHO to address this global pandemic (WHO, 2020).

In comparison to chloroquine, the natural crocin molecules (*Crocus sativus* L), digitoxigenin (*Nerium oleander*), β-Eudesmol (*Laurus nobilis* L), inhibits the main protease of the coronavirus (SARS-Cov-2) show an important antiviral power (Aanouz et al., 2020).

Progress in separation technologies makes antiviral screening, increasingly accessible (Mukhtar et al., 2008). Improved control in the study of medicinal plants makes the discovery of new natural medicines a feasible, promising prospect and in line with the preservation of nature and humans.

To cope with viral epidemics and the increase in chronic diseases, the use of medicinal plants seems to be an interesting solution increasingly used (OMS , 2013). Medicinal plants are the main source of care for 80% of the world's population (Zakaryan et al, 2017; Mukherjee, 2019) and are therefore a universal means of combating disease. Indeed, although the antiviral properties of natural metabolites were discovered particularly late, more and more research is being done on natural antiviral compounds from plants (Guinnin et al., 2015). This research started in the 1950's (Zakaryan et al, 2017), has isolated many substances with antiviral properties.

Viral infections affect 3-5 million patients annually (Ben-Shabat, 2019). The current pandemic shows the limit of allopathic antiviral treatments commonly used.

Many plant extracts used for medicinal purposes since ancient times are now known for their antiviral properties as shown by the scientific data summarized in Table 5. This medicine, whose empiricism shows good tolerance, places traditional natural-based medicine in the position of an appropriate alternative to treat viral diseases. Traditional medicine is of major economic interest to many countries (Koné et al, 2009) in the face of a conventional medicine that remains inaccessible, and therefore presents itself as an opportunity to ensure universal care accessible for all (OMS, 2013). It is also widely effective, safe, and growing especially in developed countries where it takes the name of complementary or alternative medicine (OMS, 2013).

CONCLUSION

Man has always known by intuition and a long experience distinguishes between food plants for nourishment, plants useful for improving his living environment (magic/well-being, habitat, veterinarian, trade, etc.), toxic plants for hunting and/or protection, and medicinal plants for treatment.

Thus, for millennia medicine and botany were confused. In France, it was not until 1818 that the French pharmacopoeia was born, now replaced everywhere in Europe by the European Pharmacopoeia. The "ICH" is setting up an international harmonization commission around the world. The pharmacopoeia is nothing more than a collection of mandatory and opposable standards that concretize the long experience in «Traditional Medicine» of Men. According to WHO resolution 2014-2023, the pharmacopoeias will be used tomorrow to accompany the return of herbal medicine and/or traditional medicine in the care system, knowing that nearly 80% of the world's population uses it as the main mode of care and this for access to universal care. The immune system has a fundamental function which is the protection of the body against diseases. Since the early days of «the art of healing», medicinal plants have occupied a central place. They are equipped with functional ingredients that can provide protection against various pathologies including viral. Their modes of action include strengthening and functioning of the immune system, its activation and suppression of specialized immune cells (such as white blood cells). The medicinal plants of interest in antiviral control can be of two main types: those that strengthen immunity and those that neutralize viruses directly through their metabolites.

By analysing the bibliographical results in Table 5, the two types are illustrated. Nearly 24 of the 53 plants studied, or nearly 50%, correspond to plants that were used during the months of March, April and May 2020, during the Covid 19 pandemic. Garlic bulbs are used in Burkina Faso, Morocco and France to fight respiratory symptoms and show activity against IBV (Infectious bronchitis virus). Here we find a close correspondence between tradition and research data. As for the plants that boost the immune system, there is *Sorghum bicolor* of Mossi but also *Argemone mexicana* and *C. papaya* which are examples. Highly used in the kitchen, thyme rich in vitamin A is also an asset for the immune system. Red sorghum traditionally used in a drink known to strengthen the body in epidemics in Africa actually shows the property of boosting the immune system (Table 2). We find here again a confirmation of the action traditionally recognized by the tradipraticians thanks to the scientific studies. There are those who act against HIV such as *Allium cepa, Ancistrocladus korupensis, Andrographis paniculata, D. mespiliformis, Gossypuim herbaceum, Gymnema sylvestre, Mangifera indica, Momordica charantia, Plyllanthus emblica, Thymus*

Table 5. Medicinal antiviral plants.

Plant names	Main antiviral activities	References
Allium cepa L. Alliaceae*	*Allium cepa* has been patented to be used in HIV/AIDS treatment	Yanuar et al. (2014)
Allium sativum L. Alliaceae*	Allicin and other thiosulfinates exhibit activity of the herpes simplex virus type 1 and the para-influenza virus type 3.	Webert et al. (1992)
	The garlic extract had inhibitory effects on the coronavirus IBV (Infectious bronchitis virus) in the chickens' embryo	Mohajer et al. (2016)
Ancistrocladus korupensis D.W.Thomas & Gereau Ancistrocladaceae	Its alcaloids demonstrated anticytopathic activity against HIV-1 and antimalarial activity	Hallock et al. (1998)
Andrographis paniculata (Burm.f.) Wall. Acanthaceae	Andrographolide may inhibit HIV-induced cell cycle dysregulation in HIV-1 infected individuals.	Calabrese et al. (2000)
Argemone mexicana L. Papaveraceae	Inhibition of viral multiplication and stimulation of the immune system of *Litopenaeus vannamei* against the white spot syndrome virus	Palanikumar (2018)
Artemisia herba-alba Asso*	-	-
Azadirachta indica A. Juss. Meliaceae*	Deacetyl-3-cinnamoyl-azadirachtin, from leaves, may serve as a potential inhibitor against Hepatitis C virus NS3protease.	Ashfaq et al. (2016)
Boerhavia diffusa L. Nyctaginaceae	Boeravinone H is a potential antiviral agent for the prevention and control of HCV infection	Bose et al. (2017)
Caesalpinia bonducella (L.) Fleming - Caesalpiniaceae	An root and stem ethanolic extract exhibited activity against the Vaccinia virus	Dhawan (2012), Dhar (1968)
Carica papaya L. *	Aqueous extract of *Carica papaya* leaves can potentially be used as an antiviral agent, as it helps in platelet augmentation and exhibits antiviral activity against dengue virus.	Sharma et al. (2019)
Ceiba pentandra (L.) Gaertn.*	*C. pentandra* leaf extract have potential as antiviral drug to dengue virus.	Dewi et al. (2019)
Centella asiatica (L.) Urb. Apiaceae	Asiaticoside exhibit an anti-HSV-1 and -2 activities	Yoosook et al. (2000)
Chelidonium majus L. Papaveraceae	Potential therapeutic modality for skin virus warts, especially in a young patients	Nawrot et al. (*2020)*
Cinnamomum camphora (L.) J.Presl,	-	-
Citrus medica var. limon L.	-	-
Curcuma longa L. Zingiberaceae	*Aqueous extract can be used as a safe and specific drug for patients with liver diseases caused by* hepatitis B virus (HBV) *infection.*	Kim et al. (2009)
Diospyros mespiliformis Hochst. ex A.DC.*	Chewing sticks against oral diseases often fed, in Africa, by the human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS).	Chinsembu (2015)
Eucalyptus globulus Labill.*	Téreticornate A isolated from leaves and twigs showed the highest activity in the anti-HSV-1 test (herpes simplex virus) and cypellocarpin C against HSV-2.	Lelakova and Sherif (2018)
Ficus religiosa L. Moraceae	Bark extracts inhibit infection by herpes simplex virus type 2 *in vitro*.	Ghosh et al. (2016)
Glycyrrhiza glabra L. Fabaceae	Glycyrrhizin showed antiviral activity against Japanese encephalitis virus (JEV)	Badam (1997), Ghannad et al. (2014)
	G. glabra showed the characteristics of a novel antiviral medication in anti-herpetic activities against Herpes Simplex Virus 1 (HSV-1).	Sangeetha and Rajarajan (2016)
Gossypium herbaceum L. Malvaceae	Gossypol and its derivatives of have been shown to be active against the HIV virus	Prusoff et al. (1993)
Guiera senegalensis J.F.Gmel.*	anti-hepatitis B virus (HBV)	Alam (2017)
Gymnema sylvestre (Retz.) R.Br. ex Sm. Asclepiadaceae	The gymnemic acid A and B of showed antiviral activity against influenza virus.	Sinsheimer et al. (1968)
	The methanolic extract has potent inhibition of HBV DNA polymerase and inhibitory activity of HIV-1 RT, while the ethanolic extract is positive for the inhibition of RT of HIV-1	Subashini and

Table 5. Cont'd.

	The methanolic extract has potent inhibition of HBV DNA polymerase and inhibitory activity of HIV-1 RT, while the ethanolic extract is positive for the inhibition of RT of HIV-1	Priyadharshini (2015)
Hyssopus officinalis L. Lamiaceae	Aqueous extract has a potent anti-viral agent against herpes simplex viruses (HSV) infections.	Behbahani (2009)
Melaleuca quinquenervia (Cav.) S.T.Blake*	-	-
Melissa officinalis L. Lamiaceae	Potent effect like anti-influenza virus H1N1 *in vitro*	Jalali et al. (2016)
Mentha x piperita Lamiaceae*	Peppermint can drastically and rapidly reduce the infectivity of HIV-1 virions at non-cytotoxic concentrations.	Geuenich et al. (2008)
Mitragyna inermis (Willd.) Kuntze*	-	-
Momordica charantia L. Cucurbitaceae	MAP30 an antiviral protein extracted from seeds, in combination with dexamethasone and indomethacin may improve the efficacy of anti-HIV therapy	Bourinbaiar (1995)
	The antiviral activity of the plant protein inhibited not only H1N1 and H3N2 but also H5N1 subtype.	Pongthanapisith et al. (2013)
Narcissus tazetta L. Amaryllidaceae	Its alkaloids (pretazettin and pseudolycorin) exhibit antiviral activity against choriomeningitis virus.	Ramanathan et al. (1968)
	Narcissus tazetta lectin is an antiviral agent effective against RSV (human respiratory syncytial virus) and at the beginning of the influenza A (H1N1) virus cycle.	Ooi et al. (2010)
Origanum compactum L. Lamiaceae*	-	-
Phyllanthus emblica L. Euphorbiacae	Polyphenol, putranjivin A, isolated from alcoholic fruit extract, shown significant inhibitory activity on HIV reverse transcriptase.	El-Mekkawy and Meselhy (1995)
	Sesquiterpenoid glycosides from Phyllanthus emblica with Anti-hepatitis B virus activities	Jun-Jiang and Wang (2014)
Phyllanthus niruri L. Euphorbiaceae	Niranthin isolated from *Phyllanthus niruri L.* exhibits anti-hepatitis B virus activity both *in vitro* and *in vivo.*	Sheng et al. (2014)
Phytolacca americana L. Phytolaccaceae	Antiviral protein inhibit herpes simplex virus multiplication	Aron (1980)
Punica granatum L. Lythraceae	Tannins from the pericarp were effective against genital herpes virus (HSV-2) and anti-HSV-2 activity of punicalagin.	Jadhav et al. (2012), Arunkumar et al, (2018)
Sorghum bicolor (L.) Moench*	An antiviral peptide from seeds of Sorghum bicolor L. in vitro prophylactic effect against HSV-1 infection.	Filho et al. (2008)
	Mechanism of action was an immune-boosting effect, which is interesting in light of the presence of antiviral peptides in some parts of the sorghum plant.	Ayuba et al. (2014)
Syzygium aromaticum (L.) Merr. & L.M.Perry, Myrtaceae*	S. aromaticum was active against HSV-1 (herpes simplex virus-1).	Morad et all. (2018)
Tamarindus indica L. Fabaceae	Antiviral drugs for Newcastle disease virus (NDV) and, perhaps, as scaffold for new drugs	Okoh et al. (2017)
Terminalia arjuna (Roxb. ex DC.) Wight & Arn. Combretaceae	Casuarinin, extracted from bark possesses anti- herpes simplex type 2 (HSV-2), in vitro	Cheng et al. (2002)
Terminalia belirica Wall. Combretaceae	This drug reduces the infectivity of H5N1 by more than 50% in a cell test.	Klaywong and Khutrakul (2014)

Table 5. Cont'd.

Terminalia chebula Retz. Combretaceae	Hydroalcoolic fruit extract, containing chebulagic and chebulinic acids have higher direct antiviral activity against HSV-2, a sexually transmitted infection	Kesharwani et al. (2017)
Tetraclinis articulata Mast.*	-	-
Thymus serpyllum L. Lamiaceae*	Anti-HIV properties	Bose et al, (2017)
Thymus vulgaris L. Lamiaceae*	EO active in interfering with Tat functions protein which played central role in HIV transcription.	Feriotto et al. (2018)
Trachyspermum ammi Sprague Apiaceae	Oil has potential *in vitro* antiviral activity against Japanese encephalitis virus (JEV).	Roy et al. (2015)
Trigonella foenum-graecum L.*	-	-
Vernonia amygdalina Delile Asteraceae	Treatment with leaf extracts could be a potential source of novel anti-Chikungunya virus compound. The ethyl acetate leaf extract showed a 95.5% reduction in viral load.	Chan (2016)
Withania somnifera (L.) Dunal Solanaceae	Withaferin A (WA), an active constituent of this ayurvedic herb, was active against H1N1 influenza. It causes a drop in the percentage of CD8 T cells in HIV patients.	Cai et al. (2015), Maurya et al. (2019)
Woodfordia fruticosa Kurz Lythraceae	Flower extracts, rich in gallic acid possessed anti-EV71 (anti-enterovirus 71) activity.	Choi et al. (2010)
Zingiber officinale Roscoe zingiberaceae	Fresh, but not dried, ginger is effective against human respiratory syncytial virus (HRSV).	Chang et al. (2013)
	The ginger virucidal activity of essential oils, act against the human herpes simplex virus (HSV), probably by disrupting the envelope of the herpes virus.	Camero et al. (2019)

-No antiviral activity found. *Medicinal plant traditionally used during the Covid 19 pandemic.

serpyllum, Thymus vulgaris, and *Withania somnifera*. Some are common plants in our diet such as onion, mango, thyme, and African Kaki. The mango tree remains the most interesting because it also has antiviral activity against the viruses' herpes HSV-2 and hepatitis HBV. *W. somnifera* also has activity against the H1N1 influenza virus.

For another group of plants, no antiviral action is known, directly at present. However, they are all traditionally used during viral epidemics. These are *Artemisia herba-alba* Asso known for its insecticidal and antimicrobial properties, *Cinnamomum camphora* (L.) J.Presl (antibacterial activity), *Citrus medica* var. limon L. (antibacterial and antioxydant activities), *Lavandula spica* L. (antimicrobial activity), *Lavandula stoechas* L. (antimicrobial activity), *Melaleuca quinquenervia* (Cav.) S.T.Blake, *Mitragyna inermis* (Willd.) Kuntze (antimicrobial and anti-plasmodial activities), *Origanum compactum* L. (antimicrobial activity), *Tetraclinis articulata* Mast. (Antioxidant and antibacterial activities), and finally *Trigonella foenum-graecum* L. (antioxidant activity). All these plants, mentioned above, are well known for their many biological activities. For example, their antioxidants are interesting in the fight against winter diseases because they protect white blood cells. And we know that antiviral control depends on an effective immune system, especially through its white blood cells. Plants rich in antioxidants and flavonoids reduce the symptoms of cooling. They are therefore very good candidates in the bag of the tradipraticians. Medicinal plants can strengthen the body's natural defenses in case of fatigue due to their high levels of vitamins (vitamin C) and polyphenols. Although all of these plants have no direct antiviral activity, they remain interesting, as their biological activities are aimed at helping the immune system.

To treat infectious diseases, a very large number of herbal medicines especially in traditional Chinese medicine (Lin et al, 2016) and in traditional African medicine (Bellakhadar, 1997) exist as we saw in our results of the ethnobotanical surveys of our article. These traditional medicines, as well as other complementary and alternative medicines (confers essential oils used at Lectoure), with their plants and herbal products will continue to provide treatments for many diseases, including viral epidemics for which modern medicine cannot respond. Therefore, the present study aims to show the antiviral potential of herbal extracts that remains to be explored and that is immense.

Viral epidemics are accelerating dangerously like protective reactions. We finally become the enemy, through our ignorance of nature and our incessant destruction of natural balances. Even intrinsically, the human species is attacked in its

survival codes (reproduction, self-preservation, interspecific interaction). In this particular context, a re-appropriation of our traditional empirical knowledge through a return to active use of our pharmacopoeias would be an ambitious project for the future.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ABBREVIATIONS

WHO, World Health Organization; **BC,** Before Christ; **OMS,** Organisation Mondiale de la santé; **COVID-19,** "Co" for"corona","vi" for "virus" and "D" for " disease"; **SARS-CoV-2,** SARS for, "Severe Acute Respiratory Syndrome"; **CoV,** CoronaVirus; **ANSM,** Agence nationale de sécurité du médicament et des produits de santé; **CNS,** central nervous system; **ICH,** International Council on Harmonisation; **MP,** medicinal plants.

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