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Antifungal activity of African medicinal plants: a review

Abstract

In Africa many plants are used as antifungals. However, journals analysing the work of antifungal activities of plants in West Africa in recent years are rare. This study is a synthesis of publications from 2006 to 2021 on plants traditionally used in the fight against antifungal diseases. A systematic search was carried out in the Pub Med and Google Scholar database using the following keywords: vaginitis; West Africa; antifungal activity; medicinal plants; plant extracts; for articles published from 2006 to 2021. These selected articles focus on ethnobotanical studies, *in vitro* antifungal tests and molecules isolated from these plants. A total of 46 papers were selected from 7 West African countries with 56 plants studied. Nigeria and Ivory coast did more work with 22 and 14 papers respectively and studied more plants with 23 and 17 respectively. 43% of plants show good activity *in vitro* on strains of *Candida albicans* in the laboratory with a minimum fungicide concentration and a percentage of inhibition above 50%. The most active extracts are found in Ivory coast with respectively the hexane extracts of *Terminalia mantaly* with a minimum fungicide concentration= 0.024 mg / mL and the hydroethanolic extract of *Terminalia ivorensis* with a minimum fungicide concentration of 0.097 mg / mL. It is clear that the traditional West African pharmacopoeia can make an important contribution for the management of vaginitis.

Keywords: vaginitis, West Africa, antifungal activity, plants extracts, medicinal plants

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Abbreviations: IC_{50}, concentration which inhibits 50% of the growth of germs; MIC, minimum inhibitory concentration, MFC, minimum fungicidal concentration

Introduction

Candidiasis is the most frequent fungal infection in human pathology.[1] Among the different forms of candidiasis, there is vulvovaginal candidiasis which is a frequent reason for consultation in gynecology. Vulvovaginal candidiasis ranks second after bacterial vaginosis. It is estimated that 75% of women have at least one episode of Candida vaginitis in their lifetime, of which 40% to 50% have more than one episode.[1] In addition, 5 to 8% of them develop recurrent vulvovaginal candidiasis defined by the occurrence of four episodes per year. The pathogen usually responsible is *Candida albicans*, a commensal yeast of the vaginal mucosa.[2,3] Vulvovaginal candidiasis seems to be favored by a disruption of the vaginal balance and of the local immunity mechanism allowing vaginal colonization by Candida. It is closely linked to the existence of certain factors such as hormonal changes during pregnancy, the use of oral contraceptives and local factors such as lack of hygiene.[4] Furthermore, *C. albicans* is found in 50% of cases via the maternal genital tract.[5] In newborns, the incidence of Candida infections is low compared to that of bacterial or viral infections. However, maternal -fetal contamination should not be underestimated because it remains serious and responsible for significant mortality and morbidity in low birth weight premature babies.[6] In Cameroon, a study conducted among 397 pregnant women from October 2013 to January 2014 showed a prevalence of 35.52% of cases of vulvovaginal candidiasis.[7] In Togo, a study conducted at the University Hospital of Sokode between June 2010 and August 2011 showed that the prevalence of *Candida* spp is 30.77% of the germs responsible for vaginal infections in pregnant women.[8] Another study by Balaka et al. in 2011 in Togo revealed that the prevalence of *Candida albicans* is 33.3% of the germs responsible for vaginal infections in 918 pregnant women.[9] Untreated genital tract infections can lead to complications such as infertility, premature birth, miscarriages and other infectious diseases.[10] Indeed, the difficulties of effective and efficient management of vaginitis are felt on the technical, economic and biological levels.

On the technical level, there is a delay in consultation and a lack of technical means. From an economic point of view, the high cost of drugs makes treatment difficult. Biologically, the phenomenon of antibiotic resistance due to repeated use of antibiotics leads to therapeutic failure.[11] To remedy these problems, it is necessary to have new sources of drugs. Plants represent an enormous source of chemotherapeutic agents that could be used against bacteria.[12] It is therefore necessary to study them for find the solution against this multi-resistance.[12] In West Africa, as in the rest of the continent, more than 80% of the population uses traditional medicine for their primary health care.[13] Indeed, medicine is of significant use thanks to plants which contain most of the secondary metabolites. Traditional African medicine uses many plants that can be a source of new drugs. Thus, in the West African region, a great deal of scientific research is carried out on medicinal plants identified among populations and traditional health practitioners.[14] However, the journals analyzing the work of antifungal activities of plants in West Africa on recent years are rare. Thus, the present study is an analysis of the various pharmacological publications from 2006 to 2021 relating to the plants used empirically for antifungal treatments in West Africa.

Material and methods

A systematic search was carried out in the PubMed and Google Scholar database using the following keywords: Vaginitis; West

Africa; antifungal activity; medicinal plants; plant extracts; for articles published from 2006 to 2021 and certain references of these articles. These selected articles relate to ethnobotanical studies, in vitro antifungal tests and molecules isolated from these plants. Articles published before 2006 have been excluded. West Africa, rich in plant biodiversity, includes countries with precarious socio-economic situations. The widespread traditional pharmacopoeia includes a wide variety of medicinal plants.

Results

A total of 46 articles were selected in 7 West African countries from 2006 to 2021 with 56 plants studied. These are Benin, Burkina Faso, Ivory Coast, Ghana, Nigeria, Sierra Leone and Togo. We did not find articles from other countries that met our selection criteria in the selected databases. Nigeria and Ivory coast carried out more work with 22 and 14 articles respectively and studied more plants with 23 and 17 respectively. Medicinal plants are generally identified with populations and traditional healers. Medicinal plants are then subjected to a long process of preclinical experimental studies.[14] Extracts from 23 plants out of 56 studied show good *in vitro* activity on strains of *C. albicans* in the laboratory with a MFC and a percentage of inhibition beyond 50% (Table 1 & 2). Studies from Ivory coast and Togo have reported the highest numbers of these plants with 12 and 6 respectively (Figure 1). So, 32.14% of the plants show good activity. The most active extracts are found in Ivory Coast with respectively the hexane extracts of *Terminalia mantaly* with MFC = 0.024 mg/ mL[15] and the hydroethanolic extract of *Terminalia ivorensis* with an MFC of 0.097 mg/ mL.[16] A few active molecules have nevertheless been isolated from the West African medicinal plants with antifungal activity studied.[17] This table indicates West Africa medicinal plants with antifungal activity Table 3. This table shows us some molecules isolated from plants with antifungal activity. Both molecules were isolated from *Piper guineense.*

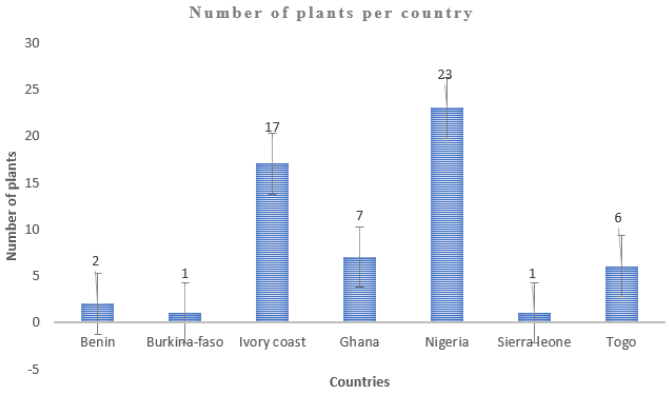

Figure 1 Number of Plants per country.

Table 1 West African plants with antifungal activity

Plants	Extraction solvent: MIC(MFC) (mg/mL) of plants	IC_{50} (µg/ml)	Countries	References
Acalypha wilkesiana	Chloroform: 50		Nigeria	18
Acanthospermum hispidum	Ethanol 70: (25)	1500	Ivory coast	19
Anogeissus leiocarpa	Ethanol: 0,195 (0,390)		Ivory coast	20
Bridelia ferruginea	Methanol: 10		Nigeria	21
	Methanol :12,5		Ivory coast	22
Calotropis procera	Ethanol :11		Nigeria	23
Carpolobia lutea	Ethanol: 25		Nigeria	24
	n-Hexane: 125		Nigeria	25
Cassia alata	Ethanol: 0,312		Togo	26
	Ethanol: 5, 60		Nigeria	27
Clausena anisata	Ethanol: 5,5		Ghana	28
Commelina nudiflora	Ethanol: 1,20		Ghana	29
Croton membranaceus	Methanol: 0,82		Ghana	30
Cymbopogon citratus	Ethanol: 12,5		Ghana	31
Distemonanthus benthamianus	Methanol: 0,25 (1)		Nigeria	32
Eclipta prostrata	Ethanol: (>50)	6250	Ivory coast	33
Exophiala dermatitidis	Water: 500		Nigeria	34
Euphorbia hirta	Methanol: 25		Nigeria	35
Ficus platyphylla	Ethanol: 0, 5 (0,5)		Togo	36
Harrisonia abyssinica	Ethanol 70: 0,78 (50)	80	Ivory coast	37
Haematostaphis barteri	Essential oil: 0,312		Nigeria	38
Hunteria eburnea	Ethanol: (25)	4000	Ivory coast	39
Khaya senegalensis	Ethanol: 7,81		Nigeria	38
	Essential oil: 0,005		Nigeria	39
Lannea schimperi,	Ethanol: 2,99		Ghana	29
Piliostigma thonningii	Dichloromethane: 0, 625		Togo	26
Piliostigma reticulatum	Ethanol: 1,2		Ghana	29
Mangifera indica	Ethanol: 31,25 (62,5)		Nigeria	42

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Table 1 Continued...

Plants	Extraction solvent: MIC(MFC) (mg/mL) of plants	IC_{50} (µg/ml)	Countries	References
Mitracarpus scaber	Hexane-water: (3, 125)	600	Ivory coast	41
Piper guineense	Ethanol: 0.039		Nigeria	17
Pycnanthus angolensis	Methanol: 12,5		Ivory coast	22
Pteleopsis suberosa	Water: 43, 49		Benin	43
Ricinus communis	Methanol: 12,5 (200)		Ghana	30
Saba comorensis	Butanol: 12,5	2	Ivory coast	42
Securinega virosa	Ethanol: 3,125 (6,250)		Ivory coast	20
Terminalia ivorensis	Ethanol 70: (0,097)	11,40	Ivory coast	16
Terminalia mantaly	Hexane: (0,024)	15	Ivory coast	15
Thonningia sanguinea	Water: (1,56)		Ivory coast	44
Trema guineensis	Water: 200 (400)	14,70	Ivory coast	45
Zanthoxylum zanthoxyloides	Methanol: 12,5		Ivory coast	22

IC_{50}: *Concentration which inhibits 50% of the growth of germs; MIC: Minimum Inhibitory Concentration, MFC: Minimum Fungicide Concentration*

Table 2 Antifungal activity with percentage inhibition and inhibition diameter of West African medicinal plants

Plants	Extraction solvent	Percentage inhibition (dose in mg/mL)	Inhibition diameter (dose in mg/mL)	Countries	References
Aframomum melegueta	Methanol		8	Nigeria	46
Allium sativum	Methanol		22	Nigeria	46
Allium cepa	Propanol		12	Nigeria	46
Bridelia ferruginea	Methanol	-250	50	Nigeria	21
Cajanus cajan	Ethanol		22	Nigeria	47
Caloncoba echinata	Xylen	44		Sierra Leonne	48
Capsicum annuum,	Methanol		8	Nigeria	46
Capsicum chinense	Methanol		7	Nigeria	46
Calotropis procera	Ethanol		11	Nigeria	23
Cassia alata	Ethanol	100 (10)		Togo	26
Chromolaena odorata	Ethanol + water	75		Togo	49
Cocos nucifera	Essential oil		22	Nigeria	50
Croton membranaceus	Methanol	7,5(20)		Ghana	30
Cymbopogon citratus	Ethanol		10	Ghana	31
Jatropha multifida	Ethanol	99, 77		Togo	49
	Ethanol+ water	99, 63		Togo	49
Khaya senegalensis	Ethanol		10	Nigeria	40
Mangifera indica	Ethyl acetate		7,5	Nigeria	51
Opillia celtidifolia	Distillated water		19	Burkina -Faso	52
Ocimum gratissimum	Essential oil		44	Nigeria	53
Phyllanthus amarus	Hexan		6	Nigeria	54
Piliostigma thonningii	Dichloromethane	100 (10)		Togo	26
Picralima nitida	Ethanol		11(200)	Nigeria	55
Sebastiania chamaelea	Ethanol		11	Benin	43
Tridax procumbens	Ethanol + water	60,44		Togo	49
Vernonia amygdalina	Ethanol		21,7 (2000)	Nigeria	56
Zingiber officinales	Methanol		9	Nigeria	46

Table 3 Molecules isolated from plants with antifungal activity

Compounds	Plants	Extraction solvent	Countries	References
Piperolongumine	*Piper guineense*	Ethanol: 39	Nigeria	17
Piperine	*Piper guineense*	Ethanol: 78	Nigeria	17

Discussion

After an ethnobotanical survey of populations and traditional healers, medicinal plants are subjected to a process of preclinical experimental studies.[14] Tube dilution methods or the agar diffusion method are the two methods used in almost all publications. Fifty-six (56) plants only were the subject of this study. The absence or little work done in other countries could be due to the absence of a research center on vaginitis or the limited financial resources given to research. This is the case of Togo. The most active extracts found in Ivory coast (hexane extracts of *Terminalia mantaly* with a MFC = 0.024 mg/mL and the hydroethanolic extract of *Terminalia ivorensis* with a MFC of 0.097 mg/mL) have an activity similar to that of Ketoconazole.[16] This

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confirms the attention in the search for new antifungal molecules. Medicinal plants have many virtues and must be sufficiently explored to effectively fight against vaginitis. A few active molecules have nevertheless been isolated from West African medicinal plants with studied antifungal activity.[17] Among these compounds, the majority of the most active are alkaloids. Previous studies have shown that the alkaloids isolated from these plants have great potential for the development of antifungal drugs.[17]

Conclusion

The present study brings out information on the effectiveness of different medicinal plants used in the treatment of vaginitis in the West African region. Although these herbs are widely used, readily available and affordable compared to conventional drugs, they are not without drawbacks. Some limitations concern the proof of their effectiveness, the lack of dosage and the safety and long-term effect. These limits in the ethnopharmacological strategy show the interest of improving the concept, and the obligation to standardize the processes, whether in the selection of antifungal medicinal plants, or in the strategies of pharmacological explorations. It is obvious that the traditional West African pharmacopoeia can make an important contribution to the discovery of safe, effective, quality and accessible phytomedicines for the management of vaginitis.

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Conflicts of interest

The authors declare that they have no competing interests.

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