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Antimicrobial Evaluation of Plants Commonly Used in the Management of Psychosis Opportunistic Infections

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Abstract: Antimicrobial activities of four medicinal plant extracts were evaluated against five bacterial strains and two fungal strains using the agar diffusion method. The ethnomedicinal plants; *Rauvolfia vomitoria* Afzel. (Apocynaceae); *Xylopia aethiopica* (Don.) A. Rich. (Annonaceae); *Aframomum melegueta* (Rose- K. Schum (Zingiberaceae) and *Piper guineense* Schum. and Thonn. (Piperaceae) used were parts of the recipes collected in a field survey of medicinal plants commonly used in folk medicine in the treatment of psychotic disorder. The anti-microbial activity of crude extracts of the plants showed that the methanol extracts demonstrated higher activity against the bacteria used compared with the n-hexane extracts except for *P. guineense* and *A. melegueta* which showed otherwise. None of the n-hexane extracts showed activity against *C. albicans* and *A. niger*. However, methanol extracts of *R. vomitoria*, *X. aethiopica*, *A. melegueta* showed activity against *C. albicans* and *A. niger*. The phytochemical analysis of *R. vomitoria* roots revealed the presence of alkaloids, saponins, cardiac glycosides but the absence of tannins, cyanogenetic glycosides and anthraquinones. *X. aethiopica* bark revealed presence of alkaloids, saponins, tannins but absence of cyanogenetic glycosides and anthraquinones. *A. melegueta* seeds revealed presence of alkaloids and saponins but absence of tannins, cyanogenetic glycosides, cardiac glycosides and anthraquinones. The antimicrobial activities demonstrated by the crude extracts of these plants offer a scientific basis for the traditional use of these plants in treatment of opportunistic infections that come with psychotic disorder.

Key words: Psychosis, opportunistic infections, medicinal plants, antimicrobial activity, phytochemical analysis

INTRODUCTION

Psychosis is a condition of mental illness that causes a person to lose his or her sense of reality. The vast majority of first episodes of psychosis occur between the ages of 14-35 years and the onset is often during a critical period in the person's development (Askey *et al*., 2007). Schizophrenia (a Greek word) is a type of psychosis meaning split mind which often describes a mental disorder characterized by impairments in the perception or expression of reality and by significant social or occupational dysfunction. A person experiencing schizophrenia is typically characterized as demonstrating disorganized thinking. People with this disease have delusions, hallucinations, disorganized speech (e.g., frequent derailment or incoherence, speaking in abstracts), grossly disorganized behaviour (e.g., dressing inappropriately, crying frequently) or catatonic behaviour (Hodgins, 1992; Hodgins *et al*., 1996). There is a correlation between having a schizophrenic syndrome and increased rates of antisocial behaviour in general and violence in particular (Angermeyer, 2000; Arseneault *et al*., 2000; Walsh *et al*., 2001; Wallace *et al*., 2004; Hodgins *et al*., 2007). The evidence that such associations are not just statistically but clinically and socially significant is now overwhelming (Brennan *et al*., 2000; Hodgins and Muller-Isberner, 2004).

The prevalence rate for schizophrenia appears to be very similar in different countries and cultures and over 10% of schizophrenia patients ultimately commit suicide (Department of Health, 2001; Addington and Burnett, 2004), this makes this disease a serious health problem among the various nationalities of the world. A high number of individuals who are hospitalized for the first onset of psychotic symptoms without having been enrolled in a specialized treatment program present with suicidal ideation, aggressive behaviours and legal problems (Verdoux *et al*., 2001; Walsh *et al*., 2003; Malla *et al*., 2005; Coid *et al*., 2006; Schothorst *et al*., 2006).

On a general note, the cause of psychosis remains unclear but it involves a combination of genetic and environmental factors (Lewis and Lieberman, 2000). Genetic linkage studies aimed at identifying schizophrenia

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susceptibility genes have identified likely chromosomes but not yet any specific genes (Rang *et al*., 2003); some environmental influences early in development have been identified as possible predisposing factors, these include maternal virus infections and high blood pressure during pregnancy. This and other evidence suggested that schizophrenia is associated with neuro-developmental disorder, affecting mainly the cerebral cortex and occurring in the first few months of prenatal development (Harrison, 1997). Psychological factors such as stress have also been noted to precipitate acute episodes of psychosis but are not the underlying cause.

The concept of 'curing' Schizophrenia is controversial, partly because there are no clear criteria for what might constitute a cure. The first line pharmacological therapy for Schizophrenia is usually antipsychotic medication. Antipsychotic drugs are thought to mainly provide symptomatic relief from the positive symptoms of psychosis. As serious as the incidence of psychosis is, there have been an age long traditional approach to its management and eventual cure. Previous experimental studies have demonstrated the efficacy of many plants in the treatment of various diseases such as diabetes, ulcer, high blood pressure, inflammation, skin infection, lung diseases, urinary tract and respiratory tract infections, epilepsy and even different kinds of cancers (Karim *et al*., 2011; Gill, 1992; Oyedeji *et al*., 1999; Aladesanmi and Odediran, 2000; Agarwal *et al*., 2004; Li *et al*., 2004; Tiwari and Madhusudana Rao, 2002; Sophia and Manoharan, 2007). Upon a previous ethnobotanical survey of anti-psychotic plants carried out by our team (Sonibare *et al*., 2008) and with consideration of the high risk of susceptibility to opportunistic infections of mentally ill patients due largely to the neglect of personal hygiene, the present study was aimed at carrying out phytochemical screening and antimicrobial evaluation of *n*-hexane and methanolic extracts of *Rauvolfia vomitoria*, *Xylopia aethiopica*, *Aframomum melegueta* and *Piper guineense*.

MATERIALS AND METHODS

Microorganisms: The organisms used, five bacteria (*Staphylococcus aureus* UCH 2278, *Escherichia coli* UCH 2127, *Klebsiella* spp. UCH 2068, *Proteus mirabilis* UCH 2061, *Pseudomonas aeruginosa* UCH 2078) and two fungal strains (*Aspergillus niger* PHM 20071 and *Candida albicans* PHM 20075) were obtained from the laboratory stock of the Department of Pharmaceutical Microbiology, University of Ibadan and University College Hospital, Ibadan as listed in Table 1.

Table 1: List of microorganisms

Organisms	Antibiogram
Staphylococcus aureus	Sen: AUG/ERY/SF/CRO
UCH 2278	Res: COT/CHL/AMX/TET/CXC/GEN/PF
Escherichia coli	Sen: CRO
UCH 2127	Res: AUG/OFL/CF/GEN/COT/AMX/PF
Pseudomonas aeruginosa	Sen:-
UCH 2078	Res: OFL/CF/PF/GEN
Proteus mirabilis	Sen: CRO/GEN/CXM/AUG
UCH 2061	Res: CF/SF/TET/AMX/COT
Klebsiella	Sen:OFL/NAL/GEN/CRO/CF/PF
UCH 2068	Res: NIT/AMX/AUG
Aspergillus niger	*PHM LAB Stock
PHM 20071	
Candida albicans	*PHM LAB Stock
PHM 20075	

*PHM LAB: Pharmaceutical micobiology laboratory

Collection and Authentication of plant materials: Plant materials were collected on the 15th of May 2006. The root of *Rauvolfia vomitoria* and leaves of *Piper guineense* were collected from the Nursery of the Department of Botany and Microbiology, University of Ibadan. The bark of *Xylopia aethiopica* was collected from the Botanical Garden, University of Ibadan while the seeds of *Aframomum melegueta* were sourced from Bodija market in Ibadan, Oyo State, Nigeria. The plants were authenticated at the Forest Herbarium Ibadan (FHI), Nigeria. Voucher specimens were deposited at the herbarium with the number: *R. vomitoria* FHI 107744; *X. aethiopica* FHI 107743; *P. guineense* FHI 107745 and *A. melegueta* FHI 107746. Extraction of plant materials, phytochemical analysis and antimicrobial screening were carried out in the Departments of Pharmacognosy and Pharmaceutical Microbiology laboratories, Faculty of Pharmacy University of Ibadan, respectively.

Extraction of plants: The air-dried plant materials were powdered with hammer mill. Extraction was done exhaustively with n-hexane and methanol using Soxhlet apparatus for each sample.

Phytochemical screening: Powdered samples were subjected to phytochemical analysis to screen for secondary metabolites using standard procedures of analysis (Harborne, 1998; Sofowora, 1993; Trease and Evans, 2002). Preliminary thin-layer chromatography was carried out on the extracts to confirm the presence of main secondary metabolites.

Antimicrobial assay: The agar-cup diffusion method (Nair *et al*., 2005; Adeniyi *et al*., 2006a, b) was used to test the activities of the plant extracts.

RESULTS AND DISCUSSION

Phytochemical analysis of *Rauvolfia vomitoria* revealed the presence of alkaloids, saponins and cardiac glycosides with the absence of tannins, cyanogenetic glycosides and anthraquinones. *Xylopia aethiopica* bark

revealed the presence of alkaloids, saponins, tannins and cardiac glycoside with the absence of cyanogenetic glycosides and anthraquinone. *Aframomum melegueta* seeds revealed the presence of only alkaloids and saponins while *Piper guineense* leaves revealed the presence of saponins and cardiac glycosides only. The results of the phytochemical analysis are presented in Table 2. Alkaloid was shown to be present in all the plants except in *Piper guineense*. Tannin was found only in *Xylopia aethiopica* in low concentration, also cardiac glycoside was sparingly present in all except in *Aframomum melegueta* where it was not found. Anthraquinones and cyanogenetic glycosides were not found in any of the plants. Results obtained from the antibacterial screening of crude extract of the four antipsychotic plants showed that the methanol crude extract demonstrated higher antibacterial activity than the *n*-hexane crude extracts. This is in line with the results of the work of Ezeifeka *et al.* (2004) in which ethanol extracts of tested plants were more effective in producing inhibition zones against the microorganisms. Also, these results confirmed the evidence in previous studies reported that alcohol is a better solvent for more consistent extraction of antimicrobially active substances from medical plants compared to other solvents (Ahmad *et al*., 1998; Cowan, 1999; Abu-Shanab *et al*., 2006; Mothana, *et al*., 2008). This may justify the traditional use of alcohol in extracting the leaf components of the medicinal plants for application against pathogens (Pandit and Langfield, 2004). The activity shown in present study was more in *Rauvolfia vomitoria* at 10 mg mL^{-1} than at 20 mg mL^{-1} with diameters of zone of inhibition of 30.0±0.0 and 28.0±2.0 on *Klebsiella* sp. and *P. mirabilis*, respectively. However, for *Aframomum melegueta* diameter of zone of inhibition was more at 20 mg mL^{-1} than at 10 mg mL^{-1} for the same organisms i.e. 30.0±2.0 and 15.0±1.7 compared to 23.0±1.5 and 15.0±3.5, respectively (Table 3). Present result on high antimicrobial activity of *R. vomitoria* conforms to the findings of Pasewu *et al.* (2008). None of the n-hexane crude extracts of the medicinal plants tested showed activity on either *Aspergillus niger* or *Candida albicans,* hence the n-hexane crude extracts of the medicinal plants investigated in this study could be said to possess no anti-fungal activity (Table 4). *Xylopia aethiopica* exerted no activity on any of the microorganisms used except on *P. aeruginosa*. *Rauvolfia vomitoria* and *A. melegueta* had activity on three organisms: *S. aureus, E. coli* and *P. aeruginosa*. In addition to producing activity on *S. aureus* and *P. aeruginosa, Piper guineense* produced activity on two other organisms namely: *Klebsiella* and *P. mirabilis*.

Table 2: Phytochemical screening of plant extract of *Aframomum melegueta, Piper guiueense, Rauvolfia vomitoria* and *Xylopia æthiopica*

Secondary metabolite	*Aframomum melegueta* (seeds)	*Piper guiueense* (leaves)	*Rauvolfia vomitoria* (roots)	*Xylopia æthiopica* (bark)
Alkaloids	+++	-	+++	+
Tannins	-	-	-	+
Saponins	+++	+++	+++	+++
Cyanogenetic glycosides	-	-	-	-
Cardiac glycoside	-	++	+	+
Anthraquinones	-	-	-	-

-: Absent +: Low concentration ++: Medium concentration +++: High concentration

The neglect of personal hygiene in mentally-ill patients is a risk factor in acquiring opportunistic infections. *Staphylococcus aureus* is the causative agent of many superlative processes ranging from localized abscesses which can occur anywhere in the body to total septicemia and pneumonia (Giller, 1975; Sleigh and Timbury, 1981). Infections can occur when *S. aureus* enters the body through breaks, cuts or abrasions in the skin or mucous membrane. *Escherichia coli* is incriminated as a pathogen outside the gut, particularly in the urinary tract and in wounds where the infection may be endogenous from the patient's intestine or acquired from an exogenous source. In line with other recent studies on the screening of antimicrobial properties of medicinal plants (Gatsing *et al*., 2010; Motamedi *et al*., 2010; Okiei *et al*., 2009), the antimicrobial evaluation of the plant extracts used in this study was carried out so as to assess the activities of the extracts against the test organisms. Some of the bacteria have been implicated in oral and dental infections, respiratory tract infections, wound and sepsis while *Candida albicans*; a fungus has been implicated in oral, vaginal and skin thrush (Hugo and Russel, 1983). The n-hexane extract of *Piper guineense* leaves had higher activity on *Proteus mirabilis*, *Staphylococcus aureus* and *Klebsiella* spp. This is in line with its reported antibacterial activity in the treatment of infectious diseases (Iwu, 1993). The methanol extract of *Rauvolfia vomitoria* showed activity against *Proteus mirabilis, Klebsiella* spp., *Escherichia coli, Aspergillus niger* and *Candida albicans*. In Southern Nigeria, a root decoction of *Rauvolfia vomitoria* is used in treatment of gonorrhoea, dressing of sores and treatment of parasitic skin diseases.

In line with results from other studies on *Aframomum melegueta* and *Xylopia aethiopica* (Konning *et al*., 2004; Oladunmoye and Dada, 2007), the methanolic extract of *Aframomum melegueta* seeds showed high activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Aspergillus niger* and *Candida albicans*. This may also be responsible for its use as antibacterial and antifungal. Most of the extracts of *Xylopia aethiopica* have shown

Table 3: Antimicrobial activities of Methanol crude extracts of four Anti-psychotic plants

		*Zone of inhibitions						
Plant extracts	Conc. (mg mL^{-1})	*S. aureus*	*E. coli*	*Klebsiella* sp.	*P. mirabilis*	*P. aeruginosa*	*A. niger*	*C. albicans*
X. aethiopica	10	-	-	-	10.0±0.0	-	-	-
	20	-	-	-	13.0±1.9	15.0±3.5	20.0±0.0	15.0±3.5
R. vomitoria	10	17.5±0.5	-	30.0±0.0	28.0±2.0	20.0±0.0	20.0±0.0	19.0±0.0
	20	22.5±3.5	-	12.5±2.5	25.8±1.4	22.5±2.5	16.0±0.0	19.0±0.0
A. melegueta	10	-	17.5±2.5	23.0±1.5	15.0±3.5	25.0±0.0	20.0±0.0	20.0±0.0
	20	24.5±0.7	22.0±2.0	30.0±2.0	15.0±1.7	30.0±0.0	24.5±0.7	20.0±0.0
P. guineeuse	10	-	13.0±0.0	-	-	-	20.0±0.0	-
	20	14.0±0.0	13.0±0.0	-	15.0±0.0	11.3±1.4	17.0±3.0	-
Gentamycin	5 μg mL^{-1}	40	31	10	37	10.0±0.0	NT	NT
Tioconazole	1%	NT	NT	NT	NT	NT	18.0±0.0	18.0±0.0

NT: Not tested, - : No zone of inhibition i.e. resistance. *Diameter of zone of inhibition (mm) of duplicate experiments±SEM

Table 4: Antimicrobial activities of n-hexane crude extracts of four Anti-psychotic plants

		*Zone of inhibitions						
Plant extracts	Conc. (mg mL^{-1})	*S. aureus*	*E. coli*	*Klebsiella* sp.	*P. mirabilis*	*P. aeruginosa*	*A. niger*	*C. albicans*
X. aethiopica	10		-	-	-	10.0±0.0	-	-
	20	-	-	-	-	15.0±0.0	-	-
R. vomitoria	10	-	-	-	-	10.0±0.0	-	-
	20	10.0±0.0	16.5±1.0	-	-	-	-	-
A. melegueta	10	15.0±0.7	30.0±0.7	-	-	23.0±2.1	-	-
	20	11.5±0.9	20.0±0.0	-	-	14.8±1.6	-	-
P. guineeuse	10	-	-	-	-	-	-	-
	20	14.0±0.0	-	10.0±0.0	19.5±0.5	12.0±2.0	-	-
Gentamycin	5 μg mL^{-1}	40	31	10	37	10	NT	NT
Tioconazole	1%	NT	NT	NT	NT	NT	16.0±0.0	18.0±0.0

NT: Not Tested, - : No zone of inhibition i.e. resistance. *Diameter of zone of inhibition (mm) of duplicate experiments±SEM

antimicrobial activity as indicated by clear zones of inhibition. Compared to hexane extracts, methanol extracts of *Rauvolfia vomitoria* (Apocynaceae); *Xylopia aethiopica* (Annonaceae); *Aframomum meleguata* (Zingiberaceae) and *Piper guineense* (Piperaceae) showed more activity against tested organisms. This also, is in line with the studies of Duraipandiyan *et al*. (2006). The antimicrobial activities demonstrated by these plant extracts are attributable to the presence of saponins in the four plants, alkaloids in most of the plants and tannins in *Xylopia aethiopica*. The antimicrobial properties exhibited by crude extracts of many plants had been traced to the presence of some of these secondary metabolites (Hans, 1952; Odebiyi, 1985; Adeniyi and Odufowora, 2000; Alqasoumi *et al*., 2008; Joseph and Raj, 2011).

Tannins have been used in medicine to aid the healing of wounds and burns. They are known to bind the proteins of exposed tissues, thus precipitating the proteins. In this form, a firm antiseptic protective coat is formed. Regeneration of new tissues takes place subsequently leading to the healing of the wound which otherwise could have been infected (Osol and Hoover, 1970; Tyler *et al*., 1981). The results from this work justify the ethno-pharmacological claims on the antimicrobial activity of the selected plant parts. It justifies their use in the various recipes employed by traditional healers in the course of treating mentally-ill patients. The target might be the ultimate treatment of psychosis. However, the antimicrobial properties of the plants ascertain a way of approaching treatment from several angles, concurrently-a holistic approach to physical, social and mental well being.

CONCLUSION

The antimicrobial activities demonstrated by the crude extracts of the ethnomedicinal plants investigated; *Rauvolfia vomitoria* Afzel. (Apocynaceae); *Xylopia aethiopica* (Don.) A. Rich. (Annonaceae); *Aframomum meleguata* (Rose- K. Schum (Zingiberaceae) and *Piper guineense* Schum. and Thonn. (Piperaceae) offer a scientific basis for the traditional use of these plants in treatment of opportunistic infections that come with psychotic disorder in mentally persons.

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