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The effect of aqueous extracts of *Zingiber officinale* (Ginger) on some microorganisms

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ABSTRACT: The crude aqueous extracts of fresh and dried rhizome of *Zingiber officinale* were screened for their antimicrobial effect. Five test organisms, *Salmonella typhi*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans* obtained from the Department of Microbiology, Ahmadu Bello University, Zaria, Nigeria, were used. All the organisms, except *P. aeruginosa*, were sensitive to the crude extracts at the concentrations tested. *C. albicans* was most sensitive by showing distinct zones of inhibition at 250 mg/ml, 500 mg/ml and 1000 mg/ml of the crude extracts of the fresh rhizome. *S. aureus*, *E. coli* and *S. typhi* were next in sensitivity by being inhibited at concetrations of 500 mg/ml and 1000 mg/ml. The growth of *S. typhi* and *C. albicans* were only inhibited at a crude extract concentration of 1000 mg/ml of the dried rhizome. These results confirm that *Zingiber officinale* possesses antimicrobial activity.

Key Words: Medicinal plants; Antimicrobial effects; Ginger; *Zingiber officinale.*

Introduction

The use of herbs and plant extracts in the treatment of human ailments is a very ancient art (Swain, 1972; One-Feghara, 1987). Although many antimicrobial agents already exist for various purposes, the search for new antimicrobial agents is continuous since the target microorganisms often evolve into new genetic variants which subsequently become resistant to existing agents. Various plant extracts from different parts of the world have been reported to possess antimicrobial activities (Hitokoto et al., 1980). Prominent among such is the preparation from avocado pear which inhibits thirteen different species of bacteria and yeasts (Neeman and Kashman, 1970). With the current trend in the biotechnology of plant cultures, it would appear that man may continue to depend on plants as a source of a number of antimicrobial agents (Curtin, 1983).

In Nigeria, several local plants have been used in the treatment of diverse ailments by the local populace. *Zingiber officinale* which is one of those plants is traditionally used in the treatment of toothache, neuralgia, rheumatic pains, catarrhal conditions, hepatitis and other liver diseases (Kucera, 1975; Sofowora, 1984). It is also included in herbal formula for the treatment of impotence (Mcleod, 1993).

In this study, the effect of crude extracts obtained from fresh and dried ginger rhizomes were tested on some microorganisms which are usually implicated in various infections and in food poisoning.

Materials and Methods

Preparation of crude aqueous extracts

Fresh ginger rhizomes obtained from Jos, Plateau State, Nigeria, were thoroughly washed with sterile distilled water and divided into two parts. One part was air-dried in hot oven at 50^{o}C to constant weight after which the bark was peeled off and the dried rhizome ground to a powdery form using a clean disinfected mortar. Fifty grams of the powder was weighed and transferred into 50 ml of sterile distilled water.

The second part (fresh rhizome) was peeled and 50g of it was weighed, crushed and transferred into 50 ml of sterile distilled water. The mixtures were thoroughly shaken and allowed to stand for 24 hrs. The coarse particles were filtered out using sterile muslin cloth. The filtrate (aqueous extract) was purified by filtration and stored at 4^{o}C.

Antimicrobial activity

Five microorganisms, namely, *Salmonella typhi, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and *Candida albicans* were employed as test organisms. A 0.1 ml aliquot of 10^{-5} dilution of a 24-hr culture was transferred into sterile Mueller-Hinton agar (Oxoid) and spread using sterile bent glass rod. A sterile cork borer was used to make wells onto the Mueller-Hinton agar plate and 0.1 ml of each concentration of the extract was introduced aseptically. For each set of experiment a control was developed in which 0.1 ml of sterile distilled water was used in place of the extract. One hour pre-diffusion time was allowed before the plates were incubated at 37^{o}C for 24 hrs. The diameters of the zones of inhibition were measured.

The sensitivity of the five microorganisms was tested against commercially available standard antibiotic discs. This was achieved by spreading 0.1 ml of 10^{-5} dilution of a 24 hr culture of the respective organisms on sterile Mueller-Hinton agar (Oxoid) plate using sterile bent glass rod. Antibiotic discs (Poly-Tes Multidisk PS003G-VE) were placed on the inoculated plates after which they were incubated at 37^{o}C for 24 hrs and the diameter of the zone of inhibition was measured. The experiments were carried out in duplicate.

Results

The crude aqueous extracts of fresh ginger rhizome inhibited the growth of *S. typhi, S. aureus* and *E. coli* only at concetrations of 500 mg/ml and 1000 mg/ml (Table 1). *C. albicans* was more sensitive as its growth was inhibited at concentrations of 250 mg/ml, 500 mg/ml and 1000 mg/ml. *P. aeruginosa* was, however, not inhibited at any of the concentrations tested.

The crude aqueous extracts of the dried rhizome showed a narrower antimicrobial activity (Table 2). It only inhibited the growth of *S. typhi* and *C. albicans* at a concentration of 1000 mg/ml. The aqueous extracts of the dried rhizome at the various concentrations could not inhibit the growth of *S. aureus, E. coli* and *P. aeruginosa*.

The commercially available standard antibiotic discs showed a wider antimicrobial activity (Table 3). The various antibiotic agents onthe discs inhibited the growth of all the test organisms, except *C. albicans* which was only inhibited by nitrofurantoin (100µg) and amoxycillin (25µg).

Table 1: Effect of aqueous extracts of the fresh rhizome of *Z. officinale* on five microorganisms

Test Organisms	Varying concentrations of aqueous extracts (mg/ml)				
	1000	500	250	125	62.5
S. typhi	++++	++	–	–	–
S. aureus	++++	++	–	–	–
E. coli	+++	+	–	–	–
C. albicans	++++	++	+	–	–
P. aeruginosa	–	–	–	–	–

The data represent the means of duplicate determinations.

++++ Zone of inhibition at 8mm.
+++ Zone of inhibition at 6mm.
++ Zone of inhibition at 4mm.
+ Zone of inhibition at 2mm.
– No zone of inhibition.

Table 2: Effect of aqueous extracts of the dried rhizome of *Z. officinale* on five microorganisms

Test Organisms	Varying concentrations of aqueous extracts (mg/ml)				
	1000	500	250	125	62.5
S. typhi	+	–	–	–	–
S. aureus	–	–	–	–	–
E. coli	–	–	–	–	–
C. albicans	+	–	–	–	–
P. aeruginosa	–	–	–	–	–

The data represent the means of duplicate determinations.

+ Zone of inhibition at 2mm.
– No zone of inhibition.

Table 3: Effect of commercially sold standard antibiotic discs (Poly-Tes MultiDisks PS003G-VE) on the five test microorganisms.

Test Organisms	N	AM	GN	CIP	TE	C	AX
S. typhi	++	++	++	+	++	++++	++++
S. aureus	++	++++	++++	++	+++	++	++
E. coli	+++	+++	++	+	++++	++++	++++
P. aeruginosa	++	+++	++	++	++++	++	+++
C. albicans	+	–	–	–	–	–	+

The data represent the means of duplicate determinations.

++++ Zone of inhibition at 8mm.
+++ Zone of inhibition at 6mm.
++ Zone of inhibition at 4mm.
+ Zone of inhibition at 2mm.
– No zone of inhibition.

N = Nitrofurantoin (100µg); AM = Ampicillin (25µg); GN = Gentamycin (10µg); CIP = Ciproxin (5µg); TE = Tetracycline (50µg); C = Chloramphenicol (30µg); AX = Amocycillin (25µg).

Discussion

The distinct zones of inhibition produced against the test organisms suggest the presence of antimicrobial principles in the crude aqueous extracts of *Zingiber officinale*. The wide disparity between the activity of the extract from the fresh rhizome compared with that of the dried rhizome is probably due to the presence of more of the antimicrobial agents such as borneol, citral, gingerol and hexahydrocurumin inthe fresh rhizome (Connell and Mclashlan, 1972). These agents are volatile and their concentration in the rhizome reduces during the drying process. Chemical analysis of *Z. officinale* has shown it to contain a mixture of over fifty constituents, mainly monoterpenes and sesquiterpenes (Williams, 1989) some of which also play significant roles in its antimicrobial activities. The ethanolic extract of the fresh rhizome has been reported to have a wide range of activities against Gram positive and Gram negative bacteria (Maskolo et al., 1989). However, no such study onthe aqueous extracts has been reported.

The nature of the susceptibility of the test organisms to the commercially available antibiotic discs further confirms the potentiality of the aqueous extracts of the fresh rhizome as good antimicrobial agent. This is because the aqueous extracts of the fresh rhizome at high concentrations inhibited all the organisms tested, except *P. aeruginosa* with comparatively wide zones of inhibition.

The results presented here suggest that fresh ginger possesses greater antimicrobial properties and may be more important as a preservative agent than dried ginger.

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