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Phytochemical screening and antibacterial effects of wild *Ganoderma* species on selected foodborne bacteria

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Abstract

This study investigated the Phytochemical and antibacterial effects of wild *Ganoderma* species on some foodborne bacteria. Standard tests were used to detect the quality and quantity of phytochemicals on the fruiting body of different wild *Ganoderma* spp as well as the Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal concentration (MBC) of the *Ganoderma* spp. against the test microorganisms. The result showed that saponin, alkaloids, anthroquinones, steroids, flavonoids, terpenoids, phytates, hydrogen cyanide, oxalates, and glycosides were present in the four *Ganoderma* samples at different concentrations. Oxalates and terpenoids were absent in *Ganoderma resinaceum, Ganoderma applanarum*, and *Ganoderma lucidum*. Cyanide recorded the highest concentration in *Ganoderma lucidum* while steroids showed least concentration level in *Ganoderma resinaceum*. The ethanolic extracts of *Ganoderma* spp. fruiting bodies showed antibacterial effect against *Salmonella* spp., *Escherichiacoli*, *Staphylococcus aureus* and *Streptococcus* spp. However, highest inhibitory concentration is observed against *Streptococcus* spp. (1.34 mg/ml) while *Salmonella* spp. has the lowest inhibitory concentration (0.318 mg/ml). The highest antibacterial activity was seen in the ethanolic extract of *Ganoderma applanarum*, against *Escherichia coli* (19.50 mg/mL) higher than the reference antibiotic streptomycin (MIC = 15.62 µg/mL). The MBC value for the four *Ganoderma* spp used showed almost uniform bactericidal (250 mg/ml) concentrations. *G. lucidum* ethanolic extract showed antibacterial activity against *Streptococcus* spp. of 16.10 mg/ml, at 500 mg/ml and lowest mean value of 8.10 mg/ml at 31.25 mg/ml. Ethanol extract on *G. praelongum* reveal highest and lowest antibacterial activity against *Staphylococcus* spp. and *Streptococcus* spp.

Keywords: Antibacterial, Ganoderma, phytochemicals, Inhibition

Introduction

Mushrooms have continued to generate a lot of interest particularly in its consumption as food, in the cure of disease, in bioremediation and as important items of commerce in Nigeria and all over the world.In Nigeria, many people in both urban and rural areas are familiar with mushroom forming fungi growing around them, some of which they exploit for food and medicine (Okhuoya *et al*., 2010), whilst toxic mushrooms are avoided. A good number of mushrooms have been reported by Akpaja *et al.* (2003, 2005), Osemwegie *et al*. (2006) and Gbolagade *et al.* (2006) to be consumed by different tribal groups in Nigeria. People depending on their tribe slightly differ in the array of mushrooms consumed and reasons for their consumption (Oso, 1975).

The peculiar properties of *Ganoderma* species are mainly due to polysaccharides or triterpenoids of the fungus. Some of the triterpenoids showed antioxidant, anticancer and antimicrobial properties (Prasad *et al*., 2008; Quereshi *et al*., 2010). It was found that extracts of *Ganoderma lucidium* from exposed dead trunk and roots of *Magnifera indica* had antibacterial activity. *Ganoderma* species like any other fungi grow wild on living or dead or dying wood log of hardwood and sometimes on dead roots. Typically found at the base of living hardwoods or occasionally on the stumps or roots of a wide range of deciduous hosts (Chang and Mshigeni, 2001). *Ganoderma* species are known to metabolically produce active compounds such as polysaccharides, adenosine, alkaloids, mannitol, organic germanium, triterpenoids, and rare minerals (Shiao, 2003). These bioactive constituents of *Ganoderma* species help to improve blood circulation, eliminate fatigue, enhance energy, strengthen the immune system, and discard toxins. During last three decades more than 150 triterpenes and more than 50 carcinostatic polysaccharides have been isolated and are known to be unique compounds in this mushroom (Kim, 2002). Mushroom nutraceutical components with potential therapeutic values are contained in *Ganoderma lucidium*. Numerous authors have shown that triterpenes and polysaccharides are the major physiologically active components of *Ganoderma lucidium* (Zhou *et al*., 2003).

There are several nonedible mushrooms seen growing in different parts of Nigeria. Among which are: *Amanita* spp., *Chlorophyllum* spp., *Psilocybe* spp., *Ganoderma* spp. etc. *Ganoderma* is largest genus in order the aphyllophorales with more than 300 species. It is known to cause root or butt rot of the hardwood trees, and also known as medicinally important mushroom in the Asian continent.

The beneficial health effects of *Ganoderma* species are attributed to different bioactive molecules such as phenolics, polysaccharides, triterpenes, sterols, lectins and proteins (Ferreira *et al*., 2010; Heleno *et al.*, 2012). Some studies with wild mushrooms reported the growth habitat as a very important factor influencing the profile and amounts of biomolecules with active principles (Heleno *et al.*, 2013). Recent studies reported ethanol and polysaccharide extracts of *G. lucidum*, as *in vitro* inhibitors of various cancer cell lines: melanoma, gastric carcinoma and inflammatory breast cancer (Martinez-Montemayor *et al*., 2011; Jang *et al*., 2011; Zheng *et al.*, 2012; Sun *et al*., 2012). Nevertheless, the mechanism of antitumour action of *G. lucidum* requires more detailed study. Although huge diversity of antibacterial drugs is currently described, bacterial resistance to first choice antibiotics has rapidly and drastically grown. Antimicrobial activity of different *G. lucidum* extracts (acetone and methanol) was also reported, indicating differences between the kind of extracts and the sample used (Alves *et al*., 2012).

This study investigates the phytochemical screening and antibacterial effects of wild *Ganoderma* species on selected foodborne bacteria.

Materials and Methods

Description of Study Area

Mushrooms were collected from the wild (the natural habitats) from different states: Bayelsa (Source: Bark of tree, over 10 years old *Magnifera indica* – *Ganoderma lucidum* and *Pleurotus pulmonarus*), Ebonyi (Source: On decaying soil organic matter – *Ganoderma resinateum*), Imo (Source: On the root of dead *Cordia mellenii* – *Ganoderma praelongum*) and Oyo (Source: Bark of *Terminalia ivorensis*-*Ganoderma applanatum*) all in Nigeria.

Collection and Identification of Mushroom Samples

The wild mushrooms fruiting bodies were collected from the natural habitats (Temperature range 22 -36℃, Humidity: 60 – 80%) in the months of February-to-June 2016. Four samples A –D of fresh *Ganoderma* species were collected from different tree hosting

plants. Sample A: *Ganoderma resinaceum*, Sample B: *Ganoderma lucidum*, Sample C: *Ganoderma applanatum*, Sample D: *Ganoderma praelongum*. Mushroom fruiting bodies of *Ganoderma* species were found growing on living and dead trunks of different tree species, and stumps in Bayelsa and Oyo states and identified by a mycologist at the Bioresource Development Centre Odi, Bayelsa State.

Mushroom Preparation

The mushrooms were gathered, cleaned and air dried for 4 days. They were cut into smaller pieces then ground with an electric grinder. Each powdered sample was put into transparent nylons, stored in plastic containers and labeled according to the species, in the order (A, B, C, D) for quick and efficient identification. Each material was stored in the dark at room temperature until the time of extraction.

Isolation and Characterization of some Food borne Bacteria

Food borne pathogens were isolated from vegetable salads red meats in the market. The isolates were characterized and identified based on Cheesborough, (2000) protocols on colonial, microscopic and biochemical tests. Pure cultures of isolates were kept on slant and stored in the refrigerator until use.

Standardization of Inoculum

The bacterial test organisms were sub-cultured onto a fresh plate of nutrient agar medium and incubated aerobically at 37 °C for 24 hrs. After incubation, a wireloop was used to transfer a little portion to a tube containing 5ml of nutrient broth. The broth culture was incubated and serially diluted until it achieved a turbidity matching McFarland standard 0.5 (1.5 x 10^8CFU/ml).

Assay for Antibacterial Activity

Agar well diffusion was used in the antimicrobial activity tests. Mueller-Hinton agar was used as the medium. The bacterial suspensions prepared to the turbulence McFarland standard 0.5 was uniformly seeded on freshly prepared surface dried Mueller Hinton agar and spread evenly using a sterile spreader. One gram (1g) of each Ganoderma extracts were reconstituted into one milliliter (1 ml) of sterile distilled water and two folds serial dilutions were performed to obtain dilutions of different concentrations (500 mg/ml, 250 mg/ml, 125 mg/ml, 62.5 mg/ml and 31.25 mg/ml). Wells were made on the Mueller Hinton agar using sterile cork borer of 6mm diameter. Ranging aliquots of 0.1 ml of reconstituted extracts were dropped in each labeled well ditch and then incubated at 37 °C for 24 hrs. The plates were observed for zones of inhibition and measured in millimeter with a transparent meter rule after incubation.

Determination of Minimum Inhibitory Concentration (MIC)

The estimation of MIC of the ganoderma extracts were carried out using the method of Akinpelu and Kolawole (2004). Two milliliters (2 ml) of nutrient broth was pipetted into several test tubes and sterilized by autoclaving at 121 °C for 20 minutes at a pressure of 15 psi. One gram (1g) of each extracts was added into 2m1 of the nutrient broth and diluted in two folds to obtained different concentrations. The dose levels of 500 mg/ml, 250 mg/ml, 125 mg/ml, and 62.5 mg/ml and 31.25 mg/ml concentrations each of the extracts were used for MIC determination. One tenth milliliter (0.1 ml) of standardized inoculum of overnight broth culture was inoculated into the dilutions and incubated at 37 °C for 24hrs. The MIC was recorded as the least concentration that inhibited the growth of the test organism using spectrophotometer at wavelength (λ) = 340 nm.

Determination of Minimum Bactericidal Concentration (MBC)

The MBC of the ganoderma extracts were determined by the method of Spencer and Spencer (2004). To determine the MBC for each set of well in the MIC determination, a loopful of broth was collected from those plates, which did not show any visible sign of growth and streaked on sterile nutrient agar. The plates were then incubated at 37 °C for 24 h. The concentration at which no visible growth was seen was noted as the minimum bactericidal concentration in mg/ml.

Results and Discussion

The results from the phytochemical screening shows that flavonoids, saponins, alkaloids, HCN, phytates, steroids, tannins were present in all the four *Ganoderma* species at different concentrations (Table 1).

Table 1: Qualitative Analysis of Phytochemical composition of some *Ganoderma* Mushrooms

Parameters	A	B	C	D	*(Control) P. pulmonarus*
Saponin	++	++	+++	++	+++
Alkaloid	+++	+++	++	+	++
Anthraquinone	+	+	+	+	-
Tannins	++	+++	++	+	++
Flavonoid	+	++	+	+++	++
Oxalates	-	-	-	++	+
Glycosides	++	++	+++	-	++
Steroids	++	+++	++	+	++
Phytate	++	++	++	++	++
Terpenoid	-	-	-	+	+
Cyanides	++	++	++	++	+

Key: - =absent, +=present, ++= doubly present, +++=highly present

This is in line with the works and propositions of Kadiri and Fasidi (1992), Akindahunsi, (2005), and Afiukwa *et al.* (2013) who detected the presence of flavonoids, saponins, alkaloids, phenol, HCN, oxalate and phytates in wild mushrooms. However, Anthroquinones were absent in *Pleurotus polmunarus*. This correlates with the findings of Edwim *et al*. (2011) who worked on 10 wild mushroom species including *Pleurotus ostreatus* with no record of Anthroquinones. Oxalates were absent *in G. resinaceum, G. applanarum,* and *G. lucidum.* Glycosides was absent *G. praelongum* while terpenoids are absent in*G. resinaceum, G. applanarum,* and *G. lucidum* (Table 1). Edwim *et al.* (2011) has reported that the presence of phytochemicals could be inherent as a result of metabolic reactions or environmental due to the substrates composition were the mushroom is inhabited.

Across the four species of *Ganoderma,* saponin contents of the mushrooms varied from 3.00-4.96% with a mean value of 3.71 ± 0.08%. The values obtained for saponin in this study are within the WHO maximum permissible limit of (48.50 mg/10g) (Table 2). The results suggest that these mushrooms could be safe for consumption. This correlates with findings of Afiukwa *et al.* (2013) on the presence of saponin on wild edible mushrooms.

The flavonoid compositions (ranges from 0.02% - 0.71% and mean value of 0.34 %± 0.03%) (Table 2) of the four mushrooms are significantly lower than the tolerable limit (52.02mg/100g) (WHO, 2003), indicating that the mushrooms are equally safe and could be good sources of anti-oxidants that boosts body immunity. This correlates with findings of Afiukwa *et al.* (2013) on the presence of flavonoids on wild edible mushrooms.

The(Hydrogen cyanide) (HCN) contents of these edible mushroom varieties suggest that the control, *Pleurotus pulminarus* (2.8mg/100g) is less poisonous than the five *Ganoderma* spp and therefore requires detoxification before consumption. The HCN content has a mean value of 6.21 ± 0.05 mg/100 g (Table 2). The results shows that the HCN contents of these fungi differ significantly ($p < 0.05$). The values compared well with the 5.8ppm reported by Chang (1994).

The alkaloid contents of these wild mushrooms ranges from 1.11 – 7.28 % with an average value of 4.71 ± 0.10% (Table 2). The highest value was detected in *Pleurotus pulminarus*. The results showed that the alkaloid concentrations of the edible mushroom is higher than the wild *Ganoderma* species but lower than the WHO safe Standard limit of (61.00mg/100 g) and also showed significant variation in the alkaloid compositions of these fungi when compared ($p < 0.05$). The values obtained indicated that the mushrooms are safe for consumption in large quantity and can help take care of various ailments. Maria *et al.* (2004)has opined that *Pleurotus* spp. are carriers of alkaloids that can be extracted for pharmaceutical purpose due to its antioxidant properties.

Oxalate concentrations for *Ganoderma praelongum, Ganoderma resinaceum* and *Pleurotus pulmonarus* ranged from 1.03 – 7.87% with a mean value of 1.67 ± 0.02% (Table 2). This shows that *Pleurotus pulmonarus* recorded lowest oxalate content. The results are much lower compared to World Health Organization tolerable limit of (105.00mg/100g)

The results obtained in this study showed a significant difference in the phytate compositions between the six species of mushroom. The phytate content of *Pleurotus pulmonarus* and *Ganoderma resinaceum* are 0.99 and 0.54% respectively. The results are lower than the standard safe limit (22.10mg/100g).

Steroids concentrations of the *Ganoderma* species ranges from 0.01-1.4% with an average value of 0.6± 0.05% (Table 2). This shows that there was an appreciable variation among the mushrooms and their concentrations are lower than the World Health Organization Standard safe limit. The results indicated that *Ganoderma applanarum* had the highest value of 1.4% against 0.6% detected in *Ganoderma praelogum.*

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Table 2 Quantitative Analysis of Phytochemical composition of some mushrooms

Parameters	A	B	C	D
Saponin (%)	3.45±0.05	3.28±0.02	4.11±0.05	3.00±0.05
Alkaloid (%)	6.34±0.02	7.11±0.05	3.33±0.01	1.11±0.01
Anthraquinone (%)	0.12±0.01	0.37±0.02	0.28±0.02	0.11±0.02
Tannins (%)	0.56±0.05	1.22±0.01	0.45±0.05	0.06±0.25
Flavonoid (%)	0.02±0.02	0.65±0.05	0.04±0.01	0.71±0.02
Oxalates (%)	-	-	-	7.87±0.05
Glycosides (%)	0.56±0.01	0.89±0.05	1.67±0.02	-
Steroids (%)	0.09±0.05	1.14±0.01	0.81±0.05	0.01±0.25
Phytate (mg/100g)	0.54±0.05	0.60±0.02	0.51±0.05	0.87±0.02
Terpenoid (%)	-	-	-	0.74±0.02
Cyanides (mg/100g)	5.11±0.02	8.16±0.05	8.11±0.05	9.90±0.05

The *Ganoderma* species were screened for antimicrobial activity (Tables 3-11). Different species of mushrooms exhibited different antimicrobial activity. These differences in antimicrobial activity are probably a consequence of the presence of different phytochemicals with antimicrobial activity. The ethanol extracts of the *Ganoderma* showed a relatively strong antimicrobial activity. The intensity of the antimicrobial effect depended on the species of mushroom, its concentration and the tested organism.

The Minimum Inhibitory Concentration (MIC) of ethanol extract of *Ganoderm aresinaceum* showed least inhibitory effects on the Gram positive and Gram negative bacteria. There was an increase inhibitory effect with decrease in the extract concentration. *Salmonella* spp shows least MIC value (0.413, at 500 mg/ml) while observing an increase to 1.342 at 31.25 mg/ml. However, of ampicillin standard of 6.25mg/ml for ethanol extract, the MIC values obtained are low. Minimum Bactericidal Concentration (MBC) of extract of *Ganoderma resinaceum* shows that *E. coli* and *Salmonella* spp have the least bactericidal concentration.

The antimicrobial susceptibility of the ethanol extract of *Ganoderma lucidum* shows that antimicrobial activity decreases with a decrease in the extract concentration. *Streptococcus* spp shows highest antimicrobial activity (16.10, at 500 mg/ml) and lowest mean value (8.10 at 31.25 mg/ml) for the bacterial test organisms. *Ganoderma lucidum* show relatively high antimicrobial activity. The MIC for *Ganoderma lucidum* is lowest with *Salmonella* spp (0.413, at 500 mg/ml) and highest with *Staphylococcus aureus* (1.33, at 31.25 mg/ml). *Streptococcus* sp. has the least bacterial concentration while the other test organisms have stable bacterial concentrationat 250 mg/ml.

The antimicrobial susceptibility pattern of *Ganoderma applanarum* revealed a decrease in the antimicrobial activity with a corresponding decrease in the extract concentrations. *Escherichia coli* (19.50, at 500 mg/ml) shows highest antimicrobial activity while *Staphylococcus aureus* has the least value for antimicrobial susceptibility. *Salmonella* sp. has the least inhibitory concentration of 0.413 while *Streptococcus* spp has the strongest MIC (1.678). The MBC for ethanol extract of *Ganoderma applanarum* shows a uniform bactericidal concentration at 250 mg/ml.

Extract of *Ganoderma praelongum* proved effective with a high antimicrobial activity (23.00, at 500mg/ml). *Staphylococcus* spp and *Streptococcus* spp demonstrated the highest and lowest antimicrobial activity respectively. *Salmonella* spp showed

the lowest MIC of 0.318 while *Streptococcus* spp is highest with 1.340. The MBC results shows that the four species of bacteria *Ganoderma praelongum* used for this study has almost uniform bacterial concentration.

Table 3: Antimicrobial Susceptibility of the Extract of *Ganoderma resinaceum*

Test organisms	Extractant (solvent)	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	Gen
Salmonella sp	Ethanol	16.10	13.00	10.30	10.00	8.00	26.80
Escherichia coli	Ethanol	20.10	16.00	13.18	11.00	9.00	26.80
Staphylococcus aureus	Ethanol	18.00	15.00	12.90	10.10	8.80	26.80
Streptococcus sp	Ethanol	19.00	15.40	11.00	9.00	8.10	26.80

Table 4: Minimum Inhibitory Concentration of Extracts of *Ganoderma resinaceum*

Extractant (solvent)	Sample material	Test organisms	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml
Ethanol	*Ganoderma resinaceum*	*Salmonella* A	0.413	0.789	0.945	1.098	1.110
Ethanol		*Salmonella* B	0.524	0.712	1.099	1.222	1.342
Ethanol		*Escherichia coli A*	0.400	0.511	0.800	0.937	1.009
Ethanol		*Escherichia coli B*	0.490	0.600	0.980	1.009	1.100
Ethanol		*Staphylococcus aureus*	0.680	0.765	0.814	0.990	1.200
Ethanol		*Staphylococcus aureus*	0.700	0.800	0.896	1.001	1.211
Ethanol		*Streptococcus* A	0.567	0.600	0.754	0.910	1.222
Ethanol		*Streptococcus* B	0.613	0.665	0.776	0.990	1.228

Table 5 Antimicrobial Susceptibility of the Extract of *Ganoderma lucidum*

Test organisms	Extractant (solvent)	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	Gen
Salmonella spp	Ethanol	14.90	12.90	10.20	8.70	8.10	26.80
Escherichia coli		12.00	10.90	10.60	8.00	8.00	26.80
Staphylococcus aureus		13.00	10.90	8.00	8.00	8.00	26.80
Streptococcus spp		16.10	12.00	12.00	9.00	8.00	26.80

Table 6: Minimum Inhibitory Concentration of Extracts of *Ganoderma lucidum*

Extractant (solvent)	Plant material	Test organisms	500 mg/l	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml
Ethanol	*Ganoderma lucidum*	*Salmonella* spp	0.413	0.489	0.745	0.998	1.110
		Escherichia coli	0.520	0.660	0.800	0.912	1.003
		Staphylococcus aureus	0.560	0.700	0.800	0.970	1.111
		Streptococcus spp	0.600	0.711	0.800	0.911	1.002

Table 7: Antimicrobial Susceptibility of the Extract of *Ganoderma applanatum*

Test organisms	Extractant (solvent)	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	Gen
Salmonella spp	Ethanol	17.10	16.00	14.30	10.50	10.00	26.80
Escherichia coli		19.50	7.00	14.00	10.60	9.00	26.80
Staphylococcus aureus		18.70	16.00	11.90	9.90	8.00	26.80
Streptococcus spp		18.00	15.60	10.70	9.10	8.00	26.80

Table 8: Minimum Inhibitory Concentration of Extracts of *Ganoderma applanatum*

Extractant (solvent)	Sample material	Test organisms	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml
Ethanol	*Ganoderma applanatum*	*Salmonella* spp	0.413	0.689	0.845	1.098	1.110
		Escherichia coli	0.469	0.616	0.890	1.110	1.228
		Staphylococcus aureus	0.500	0.619	0.828	0.998	1.160
		Streptococcus spp	0.600	0.815	0.990	1.080	1.567

Table 9: Antimicrobial Susceptibility of the Extract of *Ganoderma praelongum*

Test organisms	Extractant (solvent)	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	Gen
Salmonella spp	Ethanol	20.10	17.00	14.30	10.50	10.00	26.80
Escherichia coli		20.10	17.00	15.60	12.00	8.90	26.80
Staphylococcus aureus		23.00	18.00	13.60	10.00	10.00	26.80
Streptococcus spp		19.00	15.00	10.00	10.00	8.00	26.80

Table 10: Minimum Inhibitory Concentration of Extracts of *Ganoderma praelongum*

Extractant (solvent)	Sample material	Test organisms	500 mg/l	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml
Ethanol	*Ganoderma praelongum*	*Salmonella* spp	0.318	0.611	0.995	1.098	1.190
		Escherichia coli	0.400	0.690	0.878	0.900	1.008
		Staphylococcus aureus	0.510	0.654	0.867	0.911	1.256
		Streptococcus spp.	0.628	0.711	0.879	1.100	1.340

Table 11: Minimum Bactericidal Concentration of Extract of *Ganoderma resinaceum*

Extractant	Sample materials	Test organisms	MBC (mg/ml)
Ethanol	*Ganoderma resinaceum*	*Salmonella* spp	250
		Salmonella spp	125
		Escherichia coli	250
		Escherichia coli	125
		Staphylococcus aureus	250
		Streptococcus spp	250

Table 12: Minimum Bactericidal Concentration of Extract of *Ganoderma lucidum*

Extractant	Sample materials	Test organisms	MBC (mg/ml)
Ethanol	*Ganoderma lucidum*	*Salmonella* spp	250
		Escherichia coli	250
		Staphylococcus aureus	250
		Streptococcus spp	250
		Streptpcoccus spp	125

Table 11: Minimum Bactericidal Concentration of Extract of *Ganoderma praelongum*

Extractant	Sample materials	Test organisms	MBC (mg/ml)
Ethanol	*Ganoderma applanatum*	*Salmonella* spp	250
		Escherichia coli	250
		Staphylococcus aureus	250
		Streptococcus spp	250

Table 14: Minimum Bactericidal Concentration of Extract of *Ganoderma praelongum*

Extractant	Sample materials	Test organisms	MBC (mg/ml)
Ethanol	*Ganoderma praelongum*	*Salmonella* spp	250
		Escherichia coli	250
		Staphylococcus aureus	250
		Streptococcus spp	250

Conclusion

The phytochemical compositions observed have shown the presence of some vital bioactive compounds. The results showed that *Ganoderma* mushroom species could be safe for consumption as various phytochemical concentrations were found to be significantly lower than their World Health Organizations reported safe limits. The observed levels suggest that these mushrooms would be a good source of some natural antibiotics and antioxidants. Therefore, consumption of these mushrooms in large quantity has no toxic effect and need to be domesticated owning to its nutritional and pharmacological essence.

Inedible mushrooms in Nigeria can be utilized in a number of ways which may include establishment of sustainable regional mushroom research centers to utilize extracts from mushroom culture collections for quality control and proper packaging and preservation of these extracts and cultures of myco resources can also enhance the overall uses of mushrooms in the country; creation of public enlightenment initiatives via talk shows on the positive potentials of mushrooms and mushroom products in radio and television programs, monthly newsletter, seminars and workshops. Such knowledge could serve as a spring board for studies on different uses of the toxins of mushrooms, e.g. as biocontrol for food pathogens.

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