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Photochemical and Antimicrobial Activity of Turmeric Rhizome Extract Against Some Selected Microorgnisms

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Abstract

The use of medicinal plants in solving human health-related problems particularly that of microbial origin is an aged long practice and the quest for novel drugs from natural products to war against antibiotics resistance bacteria is at the forefront of the pharmaceutical industries. This Study investigated the antimicrobial activities of *Curcuma longa* (Turmeric) rhizome extract against *Escherichia coli*, *Staphylococcus aureus* and *Candida albicans*. Fresh turmeric rhizomes were obtained, washed, dice and dried under room temperature and was brought to fine particle size with the aid of an electric blender. 100g of the turmeric powder was weighed and dissolved in 400ml of methanol and ethanol respectively, and was allowed to stay in an orbital shaker for 48hrs. The mixture was filtered using Whatman NO1 filter paper and was distilled using a rotary evaporator. The phytochemical screening was carried out using standard method. The antimicrobial activity of the turmeric extract was determined using the agar well diffusion method. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of the extracts on the test isolates were determined using the micro broth dilution method. The phytochemical analysis reveals the presence of flavonoids, saponin, tannin and alkaloids at varying concentrations of the different extracts. The turmeric methanolic extracts recorded more antimicrobial activity with zone of inhibition of 6.0mm, 5.5mm and 7.4mm for *S. aureus*, *E. coli* and *C. albicans* respectively. The MIC of the extract on test isolates ranged from 3.55-5.0mg/ml while the MBC ranged from 5.5 – 7.4mg/ml. The research reveals that turmeric extract has a broad spectrum of activity against the test organisms and therefore, should serve as a cheap source of antimicrobial agent.

Keywords: Turmeric, Phytochemical, Antimicrobial analysis

1. Introduction

From ancient times, in India, turmeric is used as a spice, derived from the dried rhizomes of *Curcuma longa*, a member of the ginger family (Zingiberaceae). The herb is known as "Golden Spice of India." Turmeric is used in Nigeria for a number of medicinal purposes. In the traditional system of medicine, turmeric is used as an home remedy to cure a number of ailments, including anti-inflammatory, antineoplastic, anti-oxidant, anti-coagulant, antidiabetic, cardioprotective, antiulcer, hypotensive, neuroprotective, antivenin, hypocholesterolemic, and antiviral activities. *Curcuma longa* powder is known as most powerful healing herb in nature (Ramdas, 2020).

The most common part of the plant used widely is rhizome. Hot water extracts of the rhizome are taken orally in to reduce inflammation in the oral cavity. In Rasayan herb, turmeric is used as an anti-aging agent to counteract aging process (Prakash, 2017).Turmeric a native of South-East Asia, Asian countries along with Bangladesh, South East Asia, and China are using turmeric as natural coloring agent, in Spices and preservative. Curcumin is one of the most researched bioflavonoids today, and a number of studies have confirmed its antioxidant, anti-inflammatory, anti-cancer, chemoprotective, gastroprotective, and many other health properties. Most studies have proven that curcumin binds cyclooxygenase and lipoxygenase protein to produce its therapeutic response. Due to anti-inflammatory properties, turmeric has been deemed a natural wonder by recent research, giving evidences for its role in the cure of several ailments such as cancer and presenile dementia (Tsigarida, 2016). Turmeric powder has a warm, bitter, black pepper-like flavor and earthy, and mustard-like aroma.

The most of the therapeutic activities of the turmeric are due to curcumin. It is also used as hepatoprotective, nephroprotective, anticoagulant, and anti-HIV to combat AIDS. The curcumin reduces oxidative damage and amyloid pathology in an alzheimer mice and is used as spices in India and Abroad. The curcumin gold complex is obtained by combining curcumin with Auric chloride in presence of ethanol. Investigations of medicinal plants are getting importance among the scientists both for human

health and food industry.

Turmeric (*Curcuma longa*) is extensively used as spice, food preservative and coloring material in India, China and South East Asia. Various sesquiterpenes and curcuminoids have been isolated from the rhizome of *C longa*, attributing a wide array of biological activities such as anti-inflammatory, wound healing, anticancer and antibacterial activity (Tsigarida, 2016).

The use of medicinal plants in addressing human related health-challenges from microbial origin particularly the antibiotics resistant bacterial species such as *S. aureus* (MRSA) is the main-stay in pharmaceutical industries.

Staphylococcus aureus is a Gram-positive spherically shaped bacterium, a member of the Bacillota, and is a usual member of the microbiota of the body, frequently found in the upper respiratory tract and on the skin. It is often positive for catalase and nitrate reduction and is a facultative anaerobe that can grow without the need for oxygen (Mackay, 2007). Although *S. aureus* usually acts as a commensal of the human microbiota, it can also become an opportunistic pathogen, being a common cause of skin infections including abscesses, respiratory infections such as sinusitis, and food poisoning. Pathogenic strains often promote infections by producing virulence factors such as potent protein toxins, and the expression of a cell-surface protein that binds and inactivates antibodies. *S. aureus* is one of the leading pathogens for deaths associated with antimicrobial resistance and the emergence of antibiotic-resistant strains such as methicillin-resistant *S. aureus* (MRSA) is a worldwide problem in clinical medicine. Despite much research and development, no vaccine for *S. aureus* has been approved.

E. coli (*Escherichia coli*), is a type of bacteria that normally lives in your intestines. It's also found in the gut of some animals. Most types of *E. coli* are harmless and even help keep your digestive tract healthy. But some strains can cause diarrhea if you eat contaminated food or drink fouled water. While many of us associate *E. coli* with food poisoning, you can also get pneumonia and urinary tract infections from different types of the bacteria. In fact, 75% to 95% of urinary tract infections are caused by *E. coli*. *E.coli* is a normal resident of the bowel, which is how it makes it way to the urinary tract. Some versions of *E. coli* make you sick by making a toxin called Shiga. This toxin damages the lining of your intestine. The strains of *E. coli* that make the toxin are sometimes called STEC, which is short for "Shiga toxin-producing *E. coli*."

Candida albicans is part of our natural microflora or the microorganisms that commonly live in or on our bodies. It can be found in the GI tract, the mouth, and the vagina. Most of the time it causes no issues, but it's possible for overgrowths and infections to happen. *Candida albicans* is the most prevalent Trusted Source cause of fungal infections in people. Its species name, *albicans*, comes from the Latin word for "white." The yeast appears white when cultured on a plate. And in the case of certain infections, like thrush, it can create white patches.

Aspergillus is defined as a group of conidial fungi that is, fungi in an asexual state. Some of them, however, are known to have a teleomorph (sexual state) in the Ascomycota. With DNA evidence, all members of the genus *Aspergillus* are members of the phylum Ascomycota. Members of the genus possess the ability to grow where a high osmotic pressure exists (high concentration of sugar, salt, etc.). *Aspergillus* species are highly aerobic and are found in almost all oxygen-rich environments, where they commonly grow as molds on the surface of a substrate, as a result of the high oxygen tension (Toma, 2021). The present study was undertaken to investigate the effect of turmeric extract on shelf life extension of chicken and potato based cooked meal and antimicrobial activity on pure cultures of food borne pathogens in comparison to commercially available antibacterial drugs. This study investigated the antimicrobial properties of turmeric rhizome against *S. aureus*., *E. coli.*, Candida and Aspergillus.

It is expected that the success of this research work will contribute to knowledge and also make material available for further research on the subject matter.

2. Materials and Method

2.1 Study Area

The study was conducted at the Department of Biological Sciences Laboratory at Federal Polytechnic, Auchi. Auchi is located in the northern part of Edo State in Nigeria, specifically at latitude 07°04'N and longitude 06°16'E. The town has a population of over 500,000 people, as per the 2015 population census, and is situated in the south-south geographical zone of Nigeria. It is approximately 130 km away from Benin City, the capital of Edo State. Auchi is the headquarters of Etsako West Local Government Area and has experienced growth due to rural-urban migration. The town is bounded by Jattu to the north, Aviele to the south, Iyakpi to the east, and Owan Local Government Area to the west. Additionally, Auchi is the home of the Federal Polytechnic, Auchi, in Edo State, Nigeria.

2.2 Materials

The materials used for this study include the following incubator, sterile test tubes, beakers, sterile pipette, distilled water, weighing balance, Autoclave, conical flask, measuring cylinder, microscope, slide, NA (Nutrient Agar),cotton wool, petri dishes, spirit lamp, wire loop, PDA (potato Dextrose Agar) etc.

2.2.1 Sterilization of Apparatus

All apparatus were sterile to ensure they are free from contamination. The incubator, Autoclave and disinfectant were used for this purpose.

2.2.2 Source of Plant Material and Extraction

Fresh Rhizoma turmeric was purchased from Uchi Market in Auchi, Etsako West Local Government Area, Edo State. The plant was authenticated by a botanist in the department of Biological Science Laboratory Technology, Auchi Polytechnic, Auchi. The plant material was transported to the laboratory where it was placed in an over at 45^{o}C for 48 hrs. The dried Tumeric Rhizome was grinded into powder from using an electric blender. 100g of the tumeric powder was weighed using an electric weighing balance and then soaked in 400 ml of solvents used (Ethanol and Methanol) in sterile bottles and was left to stay for 48hrs in a vibrator. It was sieved filtered using a whatman filter paper No 1, and was distilled using a Rotary Evaporator. The Tumeric Rhizome extract was reconstituted using tween 80.

2.2.3 Test Organisms

All test organisms *(Staphylococusaurus, E. coil* and *Candida Albican*) used in this research work were obtained

from the cottage hospital of the federal Polytechnic, Auchi and were maintained and preserved on agar slants at 4ºC before use.

2.2.4 Antimicrobial Activity

The determination of the antimicrobial activity was carried out with sterilized nutrient agar (NA) media for (*E. coli* and *Staphylococcus aureus*), PDA media for (*Candida albicans*). The antimicrobial activity of Tumeric Rhizome extract was tested using agar well diffusion method (Bauer *et al., 2015*) [13]. The prepared culture plate were inoculated with the different test organisms by using streak plate method, wells were made on the agar using a cork borer of 7mm.

The wells were filled with the Tumeric Rhizome extract the plates were incubated in an incubator at 37ºC for 24hrs (*E. coli* and *Staphylococcus aureus*) and room temperature for 48hrs (*Candida albicans*). The plates were observed for zone of inhibition. The zone of inhibition was calculated and measured using a meter rule.

2.2.5 Phytochemical Screening of Rhizome Tumeric

The crude extract of rhizome turmeric was screened by using the standard protocol to know the presence of photochemical compounds. The extracts were subjected to photochemical tests for determination of plant secondary metabolites such as alkaloid, flavonoid, tannis, saponin, and triterpenoid/sterios (Basniwal *et al.,* 2011; Bauer *et al., 2015*) [13].

3. Result and Discussion

3.1 Result

The result of the anti-microbial activity and phytochemical screening of rhizome turmeric extract is shown below;

Table 1: Phytochemical screening of turmeric rhizome extract

Phytochemical Properties	Ethanol	Methanol
Alkaloid	_	+
Tannins and Phenolic Compound	+	+
Protein	+	+
Flavonoids	+	+
Steroids and Triterpenoids	_	_
Glycosides	+	+
Carbohydrates	+	+

Key: + = Positive (Present)
- = (Absent)

Table 2: Antimicrobial activity of turmeric rhizome methanolic extract against test organisms

Isolates	MIC	MBC
Staphylococcus aureus	3.55mg/ml	5.5mg/ml
E. coli	3.65mg/ml	5.8mg/ml
Candida albicans	5.0mg/ml	7.4mg/ml

Table 3: Minimum inhibitory concentration and minimum bacteria/concentration of the extract on the test isolates

Test Organisms	Zone of Inhibition
Staphylococcus aureus	6.0 mm
E. coli	5.5 mm
Candida albicans	7.4 mm

3.2 Discussion

The antimicrobial susceptibility test of turmeric rhizome extract against *Staphylococcus aureus*, *E coli* and *Candida albicans* were active as seen in table 2 and 3 above. This agree with the work of Negi *et al*. (1999) who reported the inhibitory effect of ethanol and hexane extract of turmeric against *Staphylococcus aureus*. Further observation revealed that methanol turmeric extract was least active showing a zone of inhibition between 5.5 mm – 7.5 mm while ethanoic turmeric extract was most active showing a zone of inhibition between 7.0 mm – 8.7 mm. Similar observations has been reported for species such as *Curcuma longa*, *Curcuma zedoari*, a *Curcuma aromatic* and *Curcuma armada* from the study of Negi *et al*. (1999), Apisariyakul *et al*. *(*1995), Yoshioka *et al*. (1998) and Majumdar *et al*. (2000).

The mechanism of action of alkaloids as an antimicrobial is by inhibiting the synthesis of nucleic acids, because it can inhibit the enzymes dihydrofolate reeducate and topoisomerase one alkaloids can disrupt the constituent components of peptidoglycan on bacterial cells so that they cell wall layers are not formed intact and cause cell death. Another mechanism of antimicrobial alkaloids is that the alkaloid component is known as DNA accelerator and inhibits bacterial cell topoisomerase enzymes(Simanjuntak, 2020; Karou *et al*.,2005).

Flavonoid provides bacterriolytic effects, inhibit protein synthesis, DNA synthesis, RNA and damage cell membrane permeability. Flavonoids have antibacterial activity because of the ability of flavonoids to interact with cell membranes and effect cell membranes bioactivity and it has reported that flavonoids are able to reduce the fluidity of bacterial cell membranes or indirect damage through autolysis/weakening of the cell wall and consequently osmotic. The mechanism of action of saponin as an antibacterial and antifungal causes lysis of the bacterial cell wall and leakage of AKP (Alkaline Phosphate), an increase in saponin concentration causes the protein to dissolve, causing intercellular compounds to diffuse through the outer membranes and cell wall. This causes cytoplasm to leak out of the cell resulting in cell death.

Tannin is a water-soluble polyphenol that can precipitate proteins. Tannin has been reported to prevent the development of microorganisms by precipitation microbial proteins and making nutrient proteins unavailable to bacteria. Tannin acts as an antimicrobial with vital proteins such as enzymes in microbial cells. Herbs that have a tannin component are astringent and are used in the treatment of intestinal disorders such as diarrhea and dysmenorrhea.

Triterpenoids has broad antimicrobial activity against filamentous bacteria, yeast and fungi. Triterpenoids are such antimicrobial because they can damage yeast cell membranes or damage lipid membranes synthesis that effect of membranes permeability resulting in cell leakage components.

4. Conclusion and Recommendations

4.1 Conclusion

The ethanol and methanol extract of Tumeric Rhizome haseffective antimicrobial activity against *Staphylococcus aureus, E. coli* and *Candida albicans*. The ethanol and methanol extract of turmeric rhizome has a group of secondary metabolites which include alkaloids, flavonoids, saponins, tannins and triterpenoid/steroids.

4.2 Recommendation

From the result of the study, it is therefore recommended that turmeric rhizome extract should be used by pharmaceutical companies/industries during the production of antimicrobial drugs against *Staphylococcus aureus*, *E. coli* and *Candida albicans* infections. It is also recommended for cosmetic industries during the production of antibacterial and anti-fungi creams. Finally, it is also recommended traditional use by traditional doctors during the production of traditional medicines.

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