ANTI-MICROBIAL ACTIVITIES OF TUMERIC RHIZOME AGAINST SOME MICRO ORGANISMS

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CERTIFICATION

This is to certify that this project work titled, **ANTIMICROBIAL ACTIVITIES OF TUMERIC RHIZOME AGAINST SOME MICRO-ORGANISMS** was carried out by **AIYA VICTORY EKATA (MAT NO: AST/2382070607)**, **ADOGA OGHELLE RACHEAL (MAT NO: AST/2382050185)** in partial fulfillment of the requirement for the award of Higher National Diploma (HND) in Biological Science Laboratory Technology department, Biology/Microbiology, option, Auchi Polytechnic Auchi.

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DEDICATION

The project is dedicated to my God almighty; the source of wisdom and knowledge and giving me the opportunity of life to do this work successfully

ACKNOWLEDGEMENT

Gratitude to Almighty God for his mercy, Grace, guidance, provision and protection for being the reason of my existence.

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In addition we will not fail to express our sincere gratitude to the stuff of Biological Science Laboratory Technology Department; the HOD BSLT. Mr. Anthony OhimaiAigbolagba and others who has been a source of encouragement in one way or the other to make sure this dream comes to fulfillment, May God in his infinite Mercy Bless you all.

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ABSTRACT

This study was carried out to investigate the antimicrobial activities of turmeric rhizomes against Escherichia coli, *Staphylococcus aureus* and *Candida albicans.* Methods: Ethanolic extract of rhizome turmeric was tested for phytochemical screening by using standard protocol. The determination of the antimicrobial activity was carried out with sterilized nutrient agar (NA) media for *(E. Coli* and *Staphylococcus aurus),* PDA media for *(candida albican).* The antimicrobial activity of Tumeric Rhizome extract was tested using agar well diffusion method. The prepared culture plate were inoculated with the different test organisms by using steak 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 37^{o}C for 24hrs (*E. Coli* and *Staphylococcus aurus*) and room temperature for 48hrs (*Candida albican*). the plates were observed for zone of inhibition. The zone of inhabitation was calculated and measured using a thread and a meter rule. The antimicrobial inhibition of ethanol and Methanol extract of rhizome turmeric against *Escherichia coli, Staphylococcus aureus* and Candida albicans microbial, Hundred (100) of 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.
Conclusions: rhizome turmeric could be used as a novel antimicrobial agent.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

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. Foods preserved with natural additives have become popular due to greater consumer awareness and concern regarding synthetic chemical additives. Food industries are looking for natural preservative with no or little adverse effects and to keep their food preserved for long period of time (Beuchat, 2019). Spices and herbs not only add flavor to food but also preserve it from different factors effecting quality of food.

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 anti-inflammatory wound healing, anticancer and antibacterial activity(Tsigarida, 2016).

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 project investigate the antimicrobial properties of turmeric rhizome. Against Staph., E. Coli., Candida and Aspergillus.

1.2 STATEMENT OF THE PROBLEM

Investigations of medicinal plants are getting importance among the scientists both for human health and food industry (Dorman and Deans 2000; Novak et al. 2000; Aligiannis et al. 2001; Bakht et al. 2011a, b, c, d; 2012 and 2013a, b). Foods preserved with natural additives have become popular due to greater consumer awareness and concern regarding synthetic chemical additives. Food industries are looking for natural preservative with no or little adverse effects and to keep their food preserved for long period of time (Beuchat 1994; Nakatani 1994). Spices and herbs not only add flavor to food but also preserve it from different factors effecting quality of food (Tsigarida et al. 2000; Skandamis and Nychas 2001; Mejlholm and Dalgaard 2002; Gill et al. 2002; Tajkarmi et al. 2010; Abdollahzadeh et al. 2014).

1.3 SCOPE OF THE STUDIES

This research is associated with Antimicrobial properties of turmeric rhizome. This research work which deals Antimicrobial properties of turmeric rhizome can serve in Nigeria for number of medicinal purposes.

These include:

- Serve as medicinal in traditional system of medicine

- Use as home remedy to cure number of ailments, like cardioprotection, antiulcer, hypotensive, antivenin, antiviral activities etc.

1.4 SIGNIFICANCE OF THE STUDY

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. This study will also be of significance importance to students of Science Laboratory Technology as it touches on their area of specialization and also to student from other to other related field and also contribute to existing data on the significance of antimicrobial quality of turmeric rhizome.

Turmeric serve as traditionally used as an antiseptic, antibacterial, anti-inflammatory, choleretic, and carminative agent in the treatment of wounds and burns, gastrointestinal and liver disorders, respiratory system diseases (e.g., asthma, cough, runny nose, sinusitis), anorexia, and rheumatism.

1.5 AIM AND OBJECTIVES OF THE STUDY

This study aims to cover the analysis that is involvedin the antimicrobial activities of turmeric rhizome.Against taphylococcus, Escherichia Coli., Candida and Aspergillus.

1.6 OBJECTIVE OF THE STUDY

The research objective of the study is to examine the antimicrobial properties of turmeric rhizome. Against Staph., E. Coli., Candida and Aspergillus.

1.7 DEFINITION OF TERMS

- **Turmeric:** Turmeric is **a member of the ginger family**. It is commonly used as a spice, but it is also known for its medicinal purposes. Turmeric contains anti-inflammatory and antioxidant properties, which may offer health benefits, turmeric may help keep your heart, joints, and brain healthy. It also may play a role in protecting against cancer and diabetes
- **Rhizomes:** rhizome, also called creeping rootstalk, horizontal underground plant stem capable of producing the shoot and root systems of a new plant.

- **Ginger:** Ginger (Zingiberofficinale) is a flowering plant whose rhizome, ginger root or ginger, is widely used as a spice and a folk medicine.

  Herb:refers to any green or leafy part of a plant used for seasoning and flavoring a recipe, but not used as the main ingredient

CHAPTER TWO

LITERATURE REVIEW

2.1 REVIEW OF RELEVANT LITERATURE

Turmeric is a flowering plant, *Curcuma longa*, of the ginger family, Zingiberaceae, the rhizomes of which are used in cooking. The plant is a perennial, rhizomatous, herbaceous plant native to the Indian subcontinent and Southeast Asia that requires temperatures between 20 and 30 °C (68 and 86 °F) and a considerable amount of annual rainfall to thrive. Plants are gathered each year for their rhizomes, some for propagation in the following season and some for consumption (Cikricki, 2018). The rhizomes are used fresh or boiled in water and dried, after which they are ground into a deep orange-yellow powder commonly used as a coloring and flavoring agent in many Asian cuisines, especially for curries, as well as for dyeing, characteristics imparted by the principal turmeric constituent, curcumin. Turmeric powder has a warm, bitter, black pepper-like flavor and earthy, mustard-like aroma.

From a number of years, the benefits of this natural drug are known among society. Kapha is reduced by turmeric extract, its powder is helpful to remove phlegm from the throat, leucorrhea – water discharge or any other discharge such as pus cells present in any open wound. Liver obstruction and jaundice are cured using turmeric in Unani System of medicines, its external application is beneficial for the removal of ulcers and reducing inflammation.

China stands at the first position in the production of turmeric. Turmeric is considered as fortunate, so it is included in several religious ceremonies in India. From ancient times, Turmeric powder was used to treat sprain and strain caused by injury (Cikricki, 2018). Due to its brilliant yellow color, turmeric is also known as “Indian saffron.”

Curcumin, a bright yellow chemical produced by the turmeric plant, is approved as a food additive by the World Health Organization, European Parliament, and United

States Food and Drug Administration. Although long used in Ayurvedic medicine, where it is also known as *haridra*, there is no high-quality clinical evidence that consuming turmeric or curcumin is effective for treating any disease.The greatest diversity of *Curcuma* species by number alone is in India, at around 40 to 45 species (Sandur, 2015). Thailand has a comparable 30 to 40 species. Other countries in tropical Asia also have numerous wild species of *Curcuma*. Recent studies have also shown that the taxonomy of *Curcuma longa* is problematic, with only the specimens from South India being identifiable as *C. longa*. The phylogeny, relationships, intraspecific and interspecific variation, and even identity of other species and cultivars in other parts of the world still need to be established and validated. Various species currently utilized and sold as "turmeric" in other parts of Asia have been shown to belong to several physically similar taxa, with overlapping local names.

Turmeric has been used in Asia for centuries and is a major part of Ayurveda, Siddha medicine, traditional Chinese medicine, Unani, and the animistic rituals of Austronesian peoples. It was first used as a dye, and then later for its supposed properties in folk medicine.From India, it spread to Southeast Asia along with Hinduism and Buddhism, as the yellow dye is used to color the robes of monks and priests. Turmeric has also been found in Tahiti, Hawaii and Easter Island before European contact (Skandamis, 2017). There is linguistic and circumstantial evidence of the spread and use of turmeric by the Austronesian peoples into Oceania and Madagascar. The populations in Polynesia and Micronesia, in particular, never came into contact with India, but use turmeric widely for both food and dye. Thus independent domestication events are also likely.Turmeric was found in Farmana, dating to between 2600 and 2200 BCE, and in a merchant's tomb in Megiddo, Israel, dating from the second millennium BCE (Chandrana, 2019). It was noted as a dye plant in the Assyrians' Cuneiform medical texts from Ashurbanipal’s library at Nineveh from 7th

century BCE. In Medieval Europe, turmeric was called "Indian saffron and called Golden Spice of India in Nigeria."

2.2 SCHORLARY REVIEWS ON ANTIMICROBIAL ACTIVITIES OF TUMERIC RHIZOME AGAINST SOME ORGANISMS

The study by investigates the antimicrobial and preservative potentials of turmeric extracts for food industry.

Meals ready-to-eat (MRE) is getting popularity in our daily life. These packed foods are designed to have a long shelf life, require very little preparation work and are perfect for emergency survival preparation. Meals are often vulnerable to contamination and subsequent growth by food borne pathogens (*Salmonella Enteritidis, Staphylococcus aureus, Campylobacter jejuni, Listeria monocytogenes*) during their preparation. There is a great concern of increasing antibiotic resistance of these pathogens (Meng et al. 1998; Perreten et al. 1998; Stermitz et al. 2000). Use of natural antibacterial compound such as extracts of spices and herbs etc., for food preservation is getting immense interest among researchers (Smid and Gorris 1999; Estevez et al. 2007; Pezeshk et al. 2011) For food preservation certain systems e.g. heating, refrigeration and addition of antimicrobial compounds are employed, however, these techniques are frequently associated with adverse changes in organoleptic characteristics and loss of nutrients. Within the disposable arsenal of preservation techniques, the food industry is keen to investigate the replacement of traditional food preservation methods by new ones due to increased consumer demands for tasty, nutritious, natural and easy-to-handle food products. Cold distribution chain have made international trade of perishable foods possible, however, refrigeration is not only very expensive but also cannot assure the quality and safety of all perishable foods. Similarly, canning preservation process is also costly, and has adverse effects on the nutritional as well as organoleptic quality of foods.

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 (Tilak et al. 2004; Kumar et al. 2006) anti-inflammatory (Sandur et al. 2007; Aggarwal and Harikumar 2009) wound healing (Maheshwari et al. 2006), anticancer (Kim et al. 2012) and antibacterial activity (Gupta and Sadhana 2005; Naz et al. 2010). Bakht J, 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.

They used turmeric extracts prepared in n-hexane, water, chloroform and ethanol which were applied to meals as preservatives and antibacterial agent. The samples were assessed microbiologically (total bacterial, total fungal and total coliform counts) and organoleptically (color, odor, taste) at day zero and after 15 days intervals. Meals autoclaved for shorter time (5 min) and treated with combination of 1 % or 2 % turmeric extract preserved for longer period.

They obtain the following results. These results were comparable with samples autoclaved for longer period (15 min) with out turmeric extract. The antibacterial activities of different turmeric extracts were also tested against *Escherichia coli, Staphylococcus aureus, Salmonella typhi* and *Candida albicans* by disc diffusion method. Water extracted samples of turmeric stored at room temperature inhibited the growth of *Escherichia coli* and *Salmonella typhi* while aqueous extract autoclaved at 121 °C for 30 min reduced the growth of *Escherichia coli* and *Staphylococcus aureus.* Methanol extracted samples stored at room temperature or autoclaved at 121 °C was effective to control the growth of all microbes under

study. They concluded that Chloroform and n-hexane extracts (stored at room temperature) showed weak activity against all tested microbes.

Investigated the antimicrobial activity of ethanol extract of rhizome turmeric (curcuma longal.) for growth of escherichia coli, staphylococcus aureus and candida albicans.

The purpose of their study was to determine at what concentration of ethanol extract of rhizome turmeric is active against Escherichia coli, Staphylococcus aureus and Candida albicans. They stated that there is a great concern of increasing antibiotic resistance of these pathogens. Use of natural antibacterial compound such as extracts of spices and herbs etc., for food preservation is getting immense interest among researchers (Smid, 2011) For food preservation certain systems e.g. heating, refrigeration and addition of antimicrobial compounds are employed, however, these techniques are frequently associated with adverse changes in organoleptic characteristics and loss of nutrients. Within the disposable arsenal of preservation techniques, the food industry is keen to investigate the replacement of traditional food preservation methods by new ones due to increased consumer demands for tasty, nutritious, natural and easy-to-handle food products. Cold distribution chain have made international trade of perishable foods possible, however, refrigeration is not only very expensive but also cannot assure the quality and safety of all perishable foods. Similarly, canning preservation process is also costly, and has adverse effects on the nutritional as well as organoleptic quality of foods.

They usedethanolicextract of rhizome turmeric for phytochemical screening by using standard protocol. Antimicrobial testing was using the diffusion disc method to measure the inhibition zone against the Escherichia coli, Staphylococcus aureus and Candida albicans with various concentration of rhizome turmeric extract (500 mg/mL, 400 mg/mL, 300 mg/mL, 200 mg/mL, 100 mg/mL, 50 mg/mL, 25 mg/mL).

The result they obtained were as follows: Phytochemical screening showed that ethanolic extract of rhizome turmeric contain alkaloids, flavonoids, saponins, tannins, and triterpenoid/steroid. The antimicrobial inhibition of ethanol extract of rhizome turmeric against Escherichia coli, Staphylococcus aureus and Candida albicansmicrobia at a concentration of 500 mg/mL had a diameter

of 15.7 mm, 15 mm and 15.18 mm with a strong category. They concluded that rhizome turmeric could be use as a novel antimicrobial agent.

BrullS., (2013). reviewed on antibacterial, antiviral, and antifungal activity of curcumin

Theirreview aims is to summarize previous antimicrobial studies of curcumin towards its application in the future studies as a natural antimicrobial agent. They stated that bacterial infections are among the important infectious diseases. Hence, over 50 years of extensive researches have been launched for achieving new antimicrobial medicines isolated from different sources. Despite progress in development of antibacterial agents, there are still special needs to find new antibacterial agents due to development of multidrug resistant bacteria (Toma, 2021). The antibacterial study on aqueous extract of *C. longa* rhizome demonstrated the MIC (minimum inhibitory concentration) value of 4 to 16 g/L and MBC (minimum bactericidal concentration) value of 16 to 32 g/L against *S. epidermis* ATCC 12228, *Staph. aureus* ATCC 25923, *Klebsiellapneumoniae* ATCC 10031, and *E. coli* ATCC 25922. The methanol extract of turmeric revealed MIC values of 16 μg/mL and 128 μg/mL against *Bacillus subtilis* and *Staph. aureus*, respectively.

Arora DS, Kaur J. (2019) study of n-hexane and ethanol turmeric extract and curcuminoids (from ethyl acetate extract of curcuminoids isolated from *C. longa* with 86.5% curcumin value) against 24 pathogenic bacteria isolated from the chicken and shrimp showed the highest antimicrobial activity for ethanol extract with the MIC value of 3.91 to 125 ppt. The

n-hexane and methanol extracts of *C. longa* demonstrated antibacterial effect against 13 bacteria, namely, *Vibrio harveyi, V. alginolyticus, V. vulnificus, V. parahaemolyticus, V. cholerae, Bacillus subtilis, B. cereus, Aeromonashydrophila, Streptococcus agalactiae, Staph. aureus, Staph. intermedius, Staph. epidermidis*, and *Edwardsiellatarda*(Mackay,

2007). However, curcuminoids elicited inhibitory activities against 8 bacteria of *Str. agalactiae, Staph. intermedius, Staph. epidermidis, Staph. aureus, A. hydrophila, B. subtilis, B. cereus,* and *Ed. tarda*. Hexane extract and curcuminoids exhibited the MIC values of 125 to 1000 ppt and 3.91 to 500 ppt, respectively.

Dorman HJD, Deans SG. (2017) Indeed, it was shown that the addition of 0.3% (w/v) of aqueous curcumin extract to the cheese caused the reduction in bacterial counts of *Salmonella typhimurium, Pseudomonas aeruginosa,* and *E. coli 0157:H7*. Moreover, it has decreased the *Staph. aureus, B. cereus,* and *Listeria monocytogenes* contamination after 14 days of cold storage period. Turmeric oil as a byproduct from curcumin manufacture also was found effective against *B. subtilis, B. coagulans, B. cereus, Staph. aureus, E. coli,* and *P. aeruginosa*. Curcumin also exhibited inhibitory activity on methicillin-resistant *Staph. aureus* strains (MRSA) with MIC value of 125–250 μg/Ml (Bauer, 2018). The *in vitro* investigation of 3 new compounds of curcumin, namely, indium curcumin, indium diacetylcurcumin, and diacetylcurcumin, against *Staph. aureus, S. epidermis, E. coli,* and *P. aeruginosa* revealed that indium curcumin had a better antibacterial effect compared to curcumin itself and it may be a good compound for further *in vivo* studies. However, diacetylcurcumin did not exhibit any antibacterial effect against tested bacteria. These results demonstrated promising antibacterial activity for different curcumin derivatives as well. The stability and assembly of FtsZprotofilaments as a crucial factor for bacterial cytokinesis are introduced as a possible drug target for antibacterial agents. Curcumin suppressed the *B. subtilis* cytokinesis through induction of filamentation. It also without significantly affecting the segregation and organization of the nucleoids markedly suppressed the cytokinetic Z-ring formation in *B. subtilis*(Beuchat, 2014). It was demonstrated that curcumin reduces the bundling of FtsZprotofilaments associated with the binding ability to FtsZ with a dissociation constant of 7.3 μM. It showed that curcumin via inhibition of assembly dynamics of FtsZ in

the Z-ring can possibly suppress the bacterial cell proliferation as one of the probable antibacterial mechanisms of action. The study on *E. coli* and *B. subtilis* demonstrated that curcumin by the inhibitory effect against FtsZ polymerization could suppress the FtsZ assembly leading to disruption of prokaryotic cell division.

Curcuma longa L. (Zingiberaceae family) and its polyphenolic compound curcumin have been subjected to a variety of antimicrobial investigations due to extensive traditional uses and low side effects. Antimicrobial activities for curcumin and rhizome extract of *C. longa* against different bacteria, viruses, fungi, and parasites have been reported.

The promising results for antimicrobial activity of curcumin made it a good candidate to enhance the inhibitory effect of existing antimicrobial agents through synergism. Indeed, different investigations have been done to increase the antimicrobial activity of curcumin, including synthesis of different chemical derivatives to increase its water solubility as well ass cell up take of curcumin. They concluded that the extensive antiviral effects of curcumin against different viral pathogens nominate this compound as an antiviral drug candidate to develop new antivirals from natural resources against sensitive viruses especially by developing different curcumin derivatives. However, using curcumin or its derivatives as antiviral compounds needs further investigations. Regarding the studies on antifungal activities of curcumin the most significant effect was found against Candida species and *Paracoccidioidesbrasiliensis,* although curcumin revealed fungicide effect against various fungi.

Lim HS., (2017) evaluated of antimicrobial activity of *curcuma longa* rhizome extract against *staphylococcus aureus*

Their aim is to investigate the in vitro antimicrobial activity of different fractions obtained from rhizome of *Curcuma longa* was investigated against standard strain and clinical isolates of *Staphylococcus aureus*. They stated that Nosocomial infections are hospital acquired infections. Historically, staphylococci, pseudomonads, and *Escherichia coli* have been the nosocomial

infection troika. It is estimated that in United States in 1995, nosocomial infections cost $4.5 billion and contributed to more than 88,000 deaths—one death every 6 min. In the study from 1990 to 1996, the three most common gram-positive *pathogens—Staphylococcus aureus,* coagulase-negative staphylococci, and enterococci— accounted for 34% of nosocomial infections, and the four most common gram-negative pathogens—*E. coli, Pseudomonas aeruginosa, Enterobacter* spp., and *Klebsiellapneumoniae*—accounted for 32% of nosocomial infections (Maheshwari, 2016).

They further stated that major force involved in nosocomial infections is indiscriminate antimicrobial use in hospitals and long-term care facilities. Widespread use of cephalosporin antibiotics is often cited as a cause of the emergence of MRSA, which became a major nosocomial threat. *S. aureus* has shown to exhibit resistance to wide range of commonly available antibiotics especially penicillin. Methicillin–resistant *S. aureus* (MRSA) is a major nosocomial pathogen. In addition to this problem, antibiotics are sometimes associated with adverse effects on the host including hypersensitivity, immune-suppression and allergic reactions (Dorman, 2013). Because of the side effects and the resistance that pathogenic microorganisms build against antibiotics, recently much attention has been paid to extracts and biologically active compounds isolated from plant species used in herbal medicine.

However, the potential of higher plants as sources for new drugs is still largely unexplored. India is the largest producer of medicinal herbs and appropriately called the botanical garden of the world (Smid, 2011). Coincidentally, the last decade has also witnessed increasing intensive studies on extracts and biologically active compounds isolated from plant species used for natural therapies or herbal medicine.

Preliminary phytochemical screening of plant was done following the standard procedures adapted by the various workers . The extracts were subjected to phytochemical tests for determination of plant secondary metabolites such as tannins, saponins, steroid, alkaloids and glycosides in accordance with.

The clinical isolates were found more sensitive for different fractions, than the standard strain of *S. aureus*. Scanning electron microscopic observations revealed that test pathogen treated with *C. longa* extract showed morphological deformity, with partial lack of the cytoplasmic membrane, which leads to cell disruption The ability of rhizome of *C. longa* extracts to inhibit the growth of test pathogen is an indication of its broad spectrum antimicrobial potential which may be employed in the management of microbial infections.

They concluded that the efficiency of turmeric fractions, such as petroleum ether, chloroform, benzene, methanol and aqueous were evaluated for their inhibitory effect on clinical and standard strains of pathogenic bacteria *S. aureus*. The methanolic fraction of *C. longa* rhizome had high potential to inhibit some pathogenic bacteria *S. aureus* to a greater degree than other fractions of *C. longa*. In our study the results show that the different fractions (petroleum ether, methanol etc.) of *C. longa* rhizome was more effective antimicrobial agents than the crude extract of *C. longa.*

2.3HEALTH BENEFITS OF TURMERIC AND CURCUMIN

The spice known as turmeric may be the most effective nutritional supplement in existence. Many high-quality studies show that turmeric has major benefits for the body and brain. Many of these benefits come from its main active ingredient, curcumin.

Turmeric is the spice that gives curry its yellow color. It has been used in India for thousands of years as both a spice and medicinal herb. Recently, science has started to back up traditional claims that turmeric contains compounds with medicinal properties. Chandrana H, Baluja S, Chanda SV. (2013)

2.4 BIOACTIVE COMPONENTS IN *TUMERIC RHIZOME*

Curcuminoids.Curcuminoids are bioactive phenolic compounds and consist of more than 100 individual curcuminoids that have been isolated and identified from genus Curcuma, about 50 of which are present in C. longa (turmeric)

1. Vitamins

Turmeric rhizome are a good source of vitamin A. It is well established that vitamin A has important functions in vision, reproduction, embryonic growth and development, immune competence and cell differentiation. Turmeric rhizome are a good source of carotenoids with pro-vitamin A potential. Bauer AW, Kirby WMM, Sherris JC, Turck M. (2015)

Turmeric rhizome also contain 200 mg/100 g of vitamin C, a concentration greater than what is found in oranges. Turmeric rhizome also protect the body from various deleterious effects of free radicals, pollutants and toxins and act as antioxidants. Turmeric rhizome are a good source of vitamin E. This is important because vitamin E not only acts as an antioxidant, but it has been shown to inhibit cell proliferation.Beuchat LR (2014)

2. Polyphenols

Turmeric rhizome are a great source of polyphenol compounds, such as flavonoids and phenolic acids. Flavonoids, which are synthesized in the plant as a response to microbial infections, have a benzo-γ-pyrone ring as a common structure. Intake of flavonoids has been shown to protect against chronic diseases associated with oxidative stress, including cardiovascular disease and cancer (Alvarez, 2014). Turmeric rhizome are a good source of flavonoids. The main flavonoids found in turmeric rhizome are myrecytin, quercetin and kaempferol, in concentrations of 5.8, 0.207 and 7.57 mg/g, respectively. Holley RA. (2013)

Quercetin is found in dried turmeric rhizome, at concentrations of 100 mg/100 g, as quercetin-3-*O*-β-d-glucoside (iso-quercetin or isotrifolin). Quercetin is a strong antioxidant, with multiple therapeutic properties. It has hypolipidemic, hypotensive, and anti-diabetic properties in obese Zucker rats with metabolic syndrome (Stohs, 2018). It can reduce hyperlipidemia and atherosclerosis in high cholesterol or high-fat fed rabbits. It can protect insulin-producing pancreatic β cells from *Streptozotocin (STZ)* induced oxidative stress and apoptosis in rats.

Phenolic acids are a sub-group of phenolic compounds, derived from hydroxybenzoic acid and hydroxycinnamic acid, naturally present in plants, and these compounds have antioxidant, anti-inflammatory, antimutagenic and anticancer properties. In dried turmeric rhizome, Gallic acid is the most abundant, with a concentration of 1.034 mg/g of dry weight (Rao, 2018). The concentration of chlorogenic and caffeic acids range from 0.018 to 0.489 mg/g of dry weight and 0.409 mg/g of dry weight, respectively.

Chlorogenic acid (CGA) is an ester of dihydrocinnamic acid and a major phenolic acid in turmeric rhizome. CGA has a role in glucose metabolism. It inhibits glucose-6-phosphate translocase in rat liver, reducing hepatic gluconeogenesis and glycogenolysis. CGA has also been found to lower post-prandial blood glucose in obese Zuckerrats and to reduce the glycemic response in rodents. CGA has anti-dyslipidemic properties, as it reduces plasma total cholesterol and triglycerides (TG) in obese Zucker rats or mice fed a high fat diet and reverses STZ-induced dyslipidemia in diabetic rats.

3. Turmeric Contains Bioactive Compounds With Medicinal Properties

However, the curcumin content of turmeric is not that high. It's around 3%, by weight. Most of the studies on this herb use turmeric extracts that contain mostly curcumin itself, with dosages usually exceeding 1 gram per day. It would be very difficult to reach these levels just using turmeric as a spice in your foods.

However, curcumin is poorly absorbed into your bloodstream. In order to experience the full effects of curcumin, its bioavailability (the rate at which your body absorbs a substance) needs to improve. It helps to consume it with black pepper, which contains piperine. Piperine is a natural substance that enhances the absorption of curcumin by 2,000% (Sandur, 2015). In fact, the best curcumin supplements contain piperine, and this makes them substantially more effective. Curcumin is also fat soluble, which means it breaks down and

dissolves in fat or oil. That's why it may be a good idea to take curcumin supplements with a meal that's high in fat.Aggarwal BB, Harikumar KB. (2012)

4. Curcumin is a natural anti-inflammatory compound

Inflammation is incredibly important. It helps fight foreign invaders and has a role in repairing damage in your body. Although acute, short-term inflammation is beneficial, it can be a concern if it becomes chronic and attacks your body's own tissues. Scientists now believe that chronic low-level inflammation can play a role in some health conditions and diseasesChandrana H, Baluja S, Chanda SV. (2013). These include:

- heart disease
- cancer
- metabolic syndrome
- Alzheimer's disease
- various degenerative conditions

5. Turmeric can increase the antioxidant capacity of the body

Oxidative damage is believed to be one of the mechanisms behind aging and many diseases. It involves free radicals, highly reactive molecules with unpaired electrons. Free radicals tend to react with important organic substances, such as fatty acids, proteins, or DNA.

The main reason antioxidants are so beneficial is that they protect your body from free radicals.

Curcumin is a potent antioxidant that can neutralize free radicals due to its chemical structure (Beuchat , 2016). In addition, animal and cellular studies suggest that curcumin may block the action of free radicals and may stimulate the action of other antioxidants. Further clinical studies are needed in humans to confirm these benefits.Kumar GS, Harish N, Shyaja MD, Salimath PV. (2016).

6. Curcumin can boost brain-derived neurotrophic factor

Before scientists had a better understanding of neurons, it was believed that they were not able to divide and multiply after early childhood. However, they now know that Is not the case.

Neurons are capable of forming new connections, and in certain areas of the brain they can multiply and increase in number. One of the main drivers of this process is brain-derived neurotrophic factor (BDNF). This is a gene that's involved in making a protein responsible for promoting the life of neurons. (Singh, 2018). The BDNF protein plays a role in memory and learning, and it can be found in areas of the brain responsible for eating, drinking, and body weight. Many common brain disorders have been linked to decreased levels of BDNF protein, including depression and Alzheimer's disease. Interestingly, animal studies have found that curcumin may increase brain levels of BDNF.Abdollahzadeh E, Rezaej M, Hosseini H. (2017)

7. Curcumin may lower your risk of heart disease

Heart disease is the number one cause of death in the world. Researchers have studied it for many decades and learned a lot about why it happens. Unsurprisingly, heart disease is incredibly complicated and various things contribute to it. Curcumin may help reverse many steps in the heart disease process. Perhaps the main benefit of curcumin when it comes to heart disease is improving the function of the endothelium, the lining of your blood vessels.

The endothelial dysfunction is a major driver of heart disease. This is when your endothelium is unable to regulate blood pressure, blood clotting, and various other factors. Several studies suggest that curcumin can lead to improvements in heart health. Additionally, one study found that it's as effective as exercise in post-menopausal women. In addition, curcumin can help reduce inflammation and oxidation (as discussed above), which can play a role in heart disease.Brull S, Coote P. (2013).

8. Turmeric may help prevent cancer

Cancer is a disease, characterized by uncontrolled cell growth. There are many different forms of cancer that appear to be affected by curcumin supplements. Curcumin has been studied as a beneficial herb in cancer treatment and been found to affect cancer growth and development.

Studies have shown that it cancontribute to the death of cancerous cells, reduce angiogenesis (growth of new blood vessels in tumors) and reduce metastasis (spread of cancer)

Whether high-dose curcumin — preferably with an absorption enhancer like piperine — can help treat cancer in humans has yet to be studied properly. However, there is evidence that it may prevent cancer from occurring in the first place, especially cancers of the digestive system like colorectal cancer.In a 30-day study in 44 men with lesions in the colon that sometimes turn cancerous, 4 grams of curcumin per day reduced the number of lesions by 40%(Beuchat, 2016).

9. Curcumin may be useful in treating Alzheimer's disease

Alzheimer's disease is the most common form of dementia and may contribute to up 70% of dementia cases.While treatment exits for some of its symptoms, there is no cure for Alzheimer's yet. That's why preventing it from occurring in the first place is so important.There may be good news on the horizon because curcumin has been shown to cross the blood-brain barrier.It is known that inflammation and oxidative damage play a role in Alzheimer's disease, and curcuminhas beneficial effects on both.In addition, a key feature of Alzheimer's disease is a buildup of protein tangles called amyloid plaques. Studies show that curcumin can help clear these plaques.Whether curcumin can slow or even reverse the progression of Alzheimer's disease in people is currently unknown and needs to be studied.Basniwal RK, Butter HS, Jain VK, Jain N. (2015).

10. Arthritis patients respond well to curcumin supplements

Arthritis is a common problem in Western countries. There are several different types of arthritis, most of which involve inflammation in the joints.Given that curcumin is a potent anti-inflammatory compound, it makes sense that it may help with arthritis. In fact, several studies show that there is an association. Cowan MM (2018).

In a study of people with rheumatoid arthritis, curcumin was even more effective than an anti-inflammatory drug.May other studies have looked at the effects of curcumin on arthritis and noted improvements in various symptoms.

11. Curcumin has benefits against depression

Curcumin has shown some promise in treating depression.

In a controlled trial, 60 people with depression were randomized into three groups. One group took Prozac, another group took 1 gram of curcumin, and the third group took both Prozac and curcumin.After 6 weeks, curcumin had led to improvements similar to those of Prozac. The group that took both Prozac and curcumin fared best.

According to this small study, curcumin is as effective as an antidepressant.Depression is also linked to reduced levels of BDNF and a shrinking hippocampus, a brain area with a role in learning and memory. Curcumin can help boost BDNF levels, potentially reversing some of these changes(Patrick, 2018).There's also some evidence that curcumin can boost the brain neurotransmitters serotonin and dopamine.Aligiannis N, Kalpoutzakis E, Mitaku S, Chinou IB (2012)

12. Curcumin may help delay aging and fight age-related chronic diseases

If curcumin can really help prevent heart disease, cancer, and Alzheimer's, it may have benefits for longevity as well.This suggests that curcumin may have potential as an anti-

aging supplement.Given that oxidation and inflammation are believed to play a role in aging, curcumin may have effects that go way beyond just preventing disease.Larmond E (2016).

2.4 EFFECTS OF *TURMERIC RHIZOME* ON THE PREVENTION OF CHRONIC DISEASE

1. Hypolipidemic Effects

Many bioactive compounds found in turmeric rhizome leaves may influence lipid homeostasis. Phenolic compounds, as well as flavonoids, have important roles in lipid regulation. They are involved in the inhibition of pancreatic cholesterol esterase activity, thereby reducing and delaying cholesterol absorption, and binding bile acids, by forming insoluble complexes and increasing their fecal excretion, thereby decreasing plasma cholesterol concentrations (Borel, 2020). The extracts of turmeric rhizome have shown hypolipidemic activity, due to inhibition of both lipase and cholesterol esterase, thus showing its potential for the prevention and treatment of hyperlipidemia.

Turmeric rhizome has a strong effect on lipid profile through cholesterol reducing effects. Cholesterol homeostasis is maintained by two processes: cholesterol biosynthesis, in which 3-hydroxymethyl glutaryl CoA (HMG-Co-A) reductase catalyzes the rate limiting process and cholesterol absorption of both dietary cholesterol and cholesterol cleared from the liver through biliary secretion. The activity of HMG-CoA reductase was depressed by the ethanolic extract of turmeric rhizome, further supporting its hypolipidemic action. Turmeric rhizome also contain the bioactive β-sitosterol, with documented cholesterol lowering effects, which might have been responsible for the cholesterol lowering action in plasma of high fat fed rats.

Saponins, found in turmeric rhizome, prevented the absorption of cholesterol, by binding to this molecule and to bile acids, causing a reduction in the enterohepatic circulation of bile acids and increasing their fecal excretion. The increased bile acid excretion is offset by

enhanced bile acid synthesis from cholesterol in the liver, leading to the lowering of plasma cholesterol (Popoola, 2019).

2. Antioxidant Effects

Due to the high concentrations of antioxidants present in turmeric rhizome, they can be used in patients with inflammatory conditions, including cancer, hypertension, and cardiovascular diseases. The β carotene found in turmeric rhizome has been shown to act as an antioxidant. The antioxidants have the maximum effect on the damage caused by free radicals only when they are ingested in combination (Patrick, 2018). A combination of antioxidants found in turmeric rhizome was proven to be more effective than a single antioxidant, possibly due to synergistic mechanisms and increased antioxidant cascade mechanisms. A recent study in children demonstrated that turmeric rhizome could be an important source of vitamin A.Cikricki S, Mozioglu E, Yylmaz H (2014).

The extract of turmeric rhizome also contains tannins, saponins, flavonoids, terpenoids and glycosides, which have medicinal properties. These compounds have been shown to be effective antioxidants, antimicrobial and anti-carcinogenic agents. Phenolic compounds are known to act as primary antioxidants, due to their properties for the inactivation of lipid free radicals or prevention of the decomposition of hydroperoxides into free radicals, due to their redox properties. These properties play a key role in neutralizing free radicals, quenching singlet or triplet oxygen, or decomposing peroxides.

The radical scavenging and antioxidant activities of the aqueous and aqueous ethanol extracts of turmeric rhizome, from different agro-climatic regions, were investigated by Siddhuraju and Becker (2015). They found that different leaf extracts inhibited 89.7–92.0% of peroxidation of linoleic acid and had scavenging activities on superoxide radicals in a dose-dependent manner in the β-carotene-linoleic acid system. Iqbal *et al.*,(2016) showed that

the environmental temperature and soil properties have significant effects on antioxidant activity of turmeric rhizome

2.5 NEGATIVE SIDE EFFECTS OF TURMERIC

It can upset the stomach

The same agents in turmeric that support digestive health can cause irritation when taken in large amounts. Some participants in studies looking at the use of turmeric for cancer treatment had to drop out because their digestion was so negatively affected. Turmeric stimulates the stomach to produce more gastric acid. While this helps some people's digestion, it can really do a number on others.Funk JL, Jennifer BF, Janice NO, Huaping Z, Barbara N (2013).

It thins the blood

Turmeric's purifying properties may also make you bleed more easily. It is not clear why this happens. Other suggested benefits of turmeric, such as lowered cholesterol and lowered blood pressure, probably have something to do with the way turmeric functions in your blood. People who take blood-thinning drugs like warfarin (Coumadin) should avoid consuming large doses of turmeric.Naz S, Safia J, Saiqa I, Farkhanda M, Farah A, Aamer A (2012).

It may stimulate contractions

Eating foods seasoned with curry can stimulate labor. Although there's little clinical data to back up this claim, studies suggest turmeric can ease symptoms of Premenstrual syndrome System. Because of its blood-thinning effects alone, pregnant women should avoid taking turmeric supplements. Adding small amounts of turmeric as a spice to food should not be a problem.

The takeaway

It appears that there are health benefits to including turmeric in your diet. The golden spice supports immune health, helps relieve pain, and can aid in digestion, among other things. But because of some of its side effects, turmeric may not be worth taking for some people.

It is important to use caution when deciding whether turmeric is something you need to try. As with any alternative therapy, speak with your doctor before you use turmeric to treat any health condition that you have.

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 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.

3.2 STERILIZATION OF APPARATUS

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

3.3 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. 100 of powder was weighed using an electric weighing balance and then soaked in 400 ml of solvents used (Ethanol and Methanil) 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.

3.4 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 4 ^{o}C before use.

3.5 ANTIMOCROBIAL ACTIVITY

The determination of the antimicrobial activity was carried out with sterilized nutrient agar (NA) media for (E. Coli and Staphylococcus aurus), PDA media for (candida albican). The antimicrobial activity of Tumeric Rhizome extract was tested using afar well diffusion method (bauer*et al, 2015*).The prepared culture plate were inoculated with the different test organisms by using steak 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 37^{o}C for 24hrs (E. Coli and Staphylococcus aurus) and room temperature for 48hrs (Candida albican). the plates were observed for zone of inhibition. The zone of inhabitation was calculated and measured using a thread and a meter rule.

3.6 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 allcaloid, flavonoid, tannis, saponin, and triterpenoid/sterios (Basniwal*et al,* 2011and Bauer *et al, 2015*).

CHAPTER FOUR

4.1 RESULT AND DISCUSSION

4.1 RESULT

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

Table 1: antimicrobial activities of tumetic rhizome ethanolic extract against test organisms

Test Organisms	Zone of Inhibition
Staphylococcus aurus	7.0 mm
E. coli	7.6 mm
Candida albican	8.7

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

Test Organisms	Zone of Inhibition
Staphylococcus aurus	6.0 mm
E. coli	5.5 mm
Candida albican	7.4 mm

Table 3: Phytochemical screening of turmeric rhizome extract

Phytochemical Properties	Ethanol	Methanol
Alkaloid	-	+
Tannins and Phenolic Compound	+	+
Protein	+	+
Flavonoids	+	+
Steriods and Triterpenoids	-	-
Glycosides	+	+
Carbohydrates	+	+

Key: + = Positive (Present)

\- = (Absent)

4.2 DISCUSSION

The antimicrobial susceptibility test of turmeric rhizome extract against staphylococcus aurus, E coli and candida albican are active as seen in table 1 and 2 above. This agree with the work ogNegi*et al* (1999) who reported the inhibotary effect of ethanol and hexame extract of turmeric against staphylococcus aurus. further observation revealed that methanol turmeric extract was least active showing a zone of inhibition between 5.5 mm – 7.5mm while ethanolic turmeric extract was most active showing a zone of inhibition between 7.0mm – 8.7mm. Similar observations has been reported for species such as candida

longa, curcuma Zedoaria, Curcuma aromatic and curcuma amada 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 I 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) and 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 causeslysis of the bacterial cell wall and leakage of AKP (Alkaline Phosphete), 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. Tannis 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

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The ethanol and methanol extract of Tumeric Rhizome has effective antimicrobial activity against staphylococcus aurus, E. coli and candida albican. The athanol and methanol extract of turmeric rhizome has a group of secondary metabolites which include alkaloids, flavonoids, saponins, tannins and triterpenoid/steroids.

5.2 RECOMMEDATION

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 aurus, E. coli and candida albican 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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