STUDENT NAMES: IGBAVBOA GIFT EBIHOMONALU, AYENERA MARIAN OMOLALOKHA

MATRIC NO: AST/6191830210, AST/6191830119

SUPERVISOR: MRS. ODION OWIASE

HEAD OF DEPARTMENT: MOMOH .O. EMMANUEL

DEPARTMENT: SCIENCE LABORATORY TECHNOLOGY, (MICROBIOLOGYOPTION)

SCHOOL: BIOLOGICAL SCIENCE AND LABORATORY TECHNOLOGY

ANTIMICROBIAL ACTIVITY OF PAWPAW LEAF (*CARICIA PAPAYA*) EXTRACTS AGAINST *ESCHERICHIA COLI AND STAPHYLOCOCCUS AUREUS*

BY

IGBAVBOA GIFT EBIHOMONALU **AST/6191830210**
AYENERA MARIAN OMOLALOKHA **AST/6191830119**

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CERTIFICATION

This is to certify that this project titled "**ANTIMICROBIAL ACTIVITY OF PAWPAW LEAF (*CARICA PAPAYA)*** was carried out by **IGBAVBOA GIFT EBIHOMONALU AST/6191830210; AYENERA MARIAN OMOLALOKHA AST/6191830119;** in partial fulfillment of the requirements for the award of Higher National Diploma (HND) in Science Laboratory Technology (Microbiology Option).

_____ _____

Mrs. Odion Owaise Date
Project Supervisor

_____ _____

Momoh .O. Emmanuel Date
Head of Department

DEDICATION

We dedicate this project to God Almighty whose infinite grace and mercy led us through in the successful completion of our course in Auchi Polytechnic and also seeing us through during this project work.

To our parents, we want to also thank you for your support during our course of study.

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ABSTRACT

Papaya plant (Carica papaya) is widely found in Indonesia. papaya is native to the tropics of the America. Almost all part of the plant can be utilized by human for food or for medicinal purpose. Fresh leaves of Papaya plant (Carica papaya) were collected in a clean polyethylene bag from Auchi in Etsako West Local Government Area of Edo State. After which it was transported to the microbiology laboratory of Auchi polytechnic. Methanol and H-hexane extract were employed for analysis. Result show that staphylococcus aureus was sensitive to methanol extracts and methanol + N-hexane extract with a zone of inhibition measuring 6mm for methanol extract and 8.0mm for methanol + N-hexane extract. Also Eschericha coli was sensitive to only methanol + N-hexane with a zone of inhibition measuring 5.0mm N-hexane extract. The antibacterial activity of paw paw(Carica papaya) leaves extracts on some human pathogenic microorganisms (Escherichia coli and Staphylococcus aureus)explains their use in native medicine for the treatment of bacterial infections. The Gram positive bacteria (S. aureus) were more sensitive to the methanol extracts as well as a combination of both methanol and N-hexane extracts, compared to the Gram negative bacteria (Escherichia coli) as shown in this study. Therefore further studies show that pharmacological evaluations, toxicological studies and possible isolation of the therapeutic antibacterial from this plant are the future challenges.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

Papaya plant (*Carica papaya*) is widely found in Indonesia. papaya is native to the tropics of the America. Almost all part of the plant can be utilized by human for food or for medicinal purpose Dawkins and Hewitt, (2003). The plants are recognized by its weak and usually unbranched soft stem yielding copious white latex and crowded by terminal cluster of large and long stalked leaves.(Dawkins et al,2003). It fruits, leaves and flowers are edible. The papaya is a tree like plant of 5 to 10m tall leaves are 50-70m in diameter with seven lobes. Fruits is 15-45cm long and 10-30cm in diameter. Nayak, (2007).

Papaya fruits contain high percentage of vitamins C,A,E, magnesium, potassium, calcium and carbohydrates, vitamin B,C and E, carotenoids and phenolic compounds are the most abundant antioxidants present in plant foods. Sherwani (2013). Papaya leaf extracts have phenolic compounds such as protocatechuic acid, P-coumaric acid, caffeic acid, kaempferol, quercertin etc. Krishna (2007). These compounds have antimicrobial activity and have been proven to be able to inhibit Rhizopus stolonifer. Nayak, (2007). Papaya is also known as the source of papain enzyme, a kind of enzyme that is utilized as meat tenderizer Reed (1976). Chymenopapain and papain are the two important

bioactive compounds present in *Carica papaya*. Papaya leaves are used to cook in some tropical countries which contain high calories than papaya fruit. Nayak et al (2007). Papaya roots, seed, and leaf extracts are used for pest control. Vijayalakshmi, (1997). Papaya leaves are made as tea for treatment of malaria. The leaves of papaya plants contains chemical compounds of karpain, substance which kills micro organism that often interfere with the digestive function.

Sherwani 2(2013) investigated the presence of phyto chemical constituents including carbohydrates, proteins, anthraquinones, flavoids, saponins, cardiac glycosides and alkaloids in the leaves extract of *Carica papaya* crushed and boiled leave extract of *C. papaya* tested for their antifungal activity against 6 yeasts. The crushed leaves extract was found to be more effective. The nutritional and medicinal application of *Carica papaya* reported by Milind and Gurditta, (2011). The whole papaya plants including its leaves, seeds, fruits and their juices is used as a traditional medicine. The prominent medicinal properties of papaya include anti-fungal, antibacterial, antitumor, wound-healing etc. Baskaran (2012) has described antimicrobial activity and phytochemical screening of ethyl acetate, acetone, chloroform, petroleum, ether, hexane, hot water, ethanol and methanol extract of *Carica papaya*. The antimicrobial activities of different solvent extracts of *Carica papaya* were tested against gram-positive and Gram-negative bacterial strains and fungus Sherwani (2012) has done comparative studies on an

antimicrobial and anti-fungal property of extracts of fresh and dried leaves of *Carica papaya*. Study repeated by various concentration of extract using the disc diffusion method. *Carica papaya* leaves showed better antibacterial activity than antifungal activity.

The efficacy of treatment with *Carica papaya* is dependent on the quantity of the different compounds in the preparations. In Indonesia, papaya leaves are used as feed for animals after parturition -2 leaves boiled in water fed every 2 days for 1 week. It has also been reported that papaya leaf extracts is used as profilaxis against malaria Satrija (1994). The medicinal folks uses the leaves poultice onto nervous pains and elephantoid growths. The leaf smoked for asthma relief in various remote areas. Javanese believe that eating papaya prevent rheumatism. dietary papaya does reduce urine acidity in human while the flowers have been used for jaundice. The young leaves and to lesser degree other parts contain carpain, an active bitter alkaloid which has a depressing action on heart. the plant is a strong amoebicide Reed, (1976).

1.2 AIM OF STUDY

To determine the antimicrobial activity of pawpaw leaf (*Carica papaya*) extracts against *Eschericha coli*

1.3 STATEMENT OF PROBLEM

Non standardized procedures of extract may lead to the degradation of the phyto chemical present in the plant and may lead to the variations thus leading to lack of reproducibility.

1.4 SCOPE OF STUDY

To observe the chemical and biological antimicrobial potential of pawpaw leaf (*Carica papaya*) extracts against *Eschericha coli*

1.5 OBJECTIVE OF STUDY

- To assess the antimicrobial effect to papaya leaf extract against *Eschericha coli.*
- To determine the extract ability against other pathogenic bacteria.

1.6 LIMITATION OF STUDY

The technique for the extraction is time consuming.

The presence of bioactive compound may hinder the growth of *Escherichia coli*.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CARICA PAPAYA

Papaya have always held an attraction for people there is a great economic importance to tropical regions where it is widely grown for its edible fruit and latex. *Carica papaya* a small group of trees with their leaves in the terminal clusters and latex vessels throughout their tissue. There are about 40 species of the genus carica in the America tropics and subtropics and papaya originated in southern mexico and central America. The early Spanish and Portuguese explorers carried it to the carribean and south East Asia during the Spanish exploration in the 16th century. It is distributed rapidly to India Oceania, Africa and today it is grown throughout the tropical and warmer subtropical areas of the world. Morton, (1987).

2.2 BOTANIC DESCRIPTION

Papaya (*Carica papaya* L.) is a member of *Caricaeeae family*. The family comprises of 31 species in the four genera: three genera from America (*Carica, Jacaritia and Jarilla*) and one from equatorial Africa (*cylicomorpha). Carica papaya* is a perennial herbaceous plant with copious milky latex reaching to 20 or 30 ft. (6-10m) tall, the stem cylindrical to 10 in (25cm) thick, hollow, usually unbranched above the middle and roughened with leaf scars. Papaya normally flowers in 9 to 12 months producing whether male, female or hermaphrodite

flowers. Nakasone and Paul (1998). Fruit is extremely variable is size and shape according to variety. It may be nearly round, pear shaped, oral of oblong: that of a wild plants may be as small as a hens egg while in cultivation the fruit ranges from 5 in (12.5cm) to 2ft (60cm) in height and up to 8 in (20cm) thick. The fruit skin is smooth, relatively thin, deep yellow to orange or salmon-red, sweet and more or less musky. The central cavity of the fruit is lined with a dryish, pulpy membrane to which adhere with numerous black, rough peppery seeds each with a glistening transparent gelatinous coating. Morton, (1987).

2.3 ORIGIN AND DISTRIBUTION

The origin of *Carica papaya* is in tropical America. Its seed were distributed from the carribean to Malacca and India by travelers and botanist in the eighteeth century. The distribution was continued throughout Asia and pacific. *Carica papaya* is grown in all tropical countries and many subtropical countries between 32^0 North and South latitudes but the high commercial production is found between 23^0 North and South latitudes. Nakasone and Paul (1998).

2.4 MORPHOLOGY

Most member of *Caricaceae* are trees or shrubs (three *Jarilla* species from mexico and Guatemala are herbs). All species produce latex that can be white or light yellow. Leaves vary from entire to deeply lobed or palmate. The flowers in

Caricaceae are monochnous (unisexual). Male flowers are mostly borne in an inflorescence with more than ten flowers. They have a tubular corolla, filled with sweet nectar nectaries are located on a small pistollode (Non functional ovary): stamens are fused to the corolla throat and distributed in two pentamerous whorls. Female flowers are often solitary or unbrunchedin few-flowered inflorescences (few species present congested female inflorescences) they are devoid of nectar; petals not fused (with few exceptions); ovaries are divided into one or five chambers (locules); there are five stimags that are either entire or bifurcated. Fruit are berries with many seeds. The seeds are surrounded by a mucilaginous arils; the testa can be ornamented or not Aravind, Debjit (2013).

2.5 CLASSIFICATION AND NOMENCLATURE

The family *Caricaceae* is comprised of four genera *Carica, Clcyclimorpha Jacaratia* and *Jarilla* .The genera *Cyclimorpha, Jacaratia* and *Jarilla* are small size trees with papain found in every part of the tree.

Most edible papaya is classified under the section Carica. Some example are *Carica pentagona, Carica pubescens, Carica stipulata, Carica cardamarcensis, Carica monoica, Carica erythrocarps, Carica goudotians* and *Carica quercifolia.* Only carica genus has been planted for the fruit (Chan and Teo, 1994). *Carica*

papaya is classified under the Division: *Magnoliophyta class: Magnoliopside; subclass: Dilleniidae;* order*: Violales;* and family: *Caricaceae.*

2.6 CHARACTERISTICS

Stem

The stem is cylindrical, 10-30cm in diameter at the base to 5-10cm at the crown, hollow with prominent leaf scars and spongy fibrous tissues it has extensive rooting system. Stem density is only 0.13g cm^3. The single stem provide structural support, body, mass, storage capacity, defense substance height and competitive ability and carries a bidirectional flow of water, nutrients, various organic compounds, chemical and physical signals that regulate root and shoot relations Morton, (1987).

Leaves

The Cluster of leaves at the apex and along the upper of the stem makes up the foliage on tree. New leaves emerge from the apex and old leaves deteriorate and fall. Leaves are palmately lobed with prominent venation. The blade is deeply divided into 7-11 segment and can be measured 40-50cm in diameter with 15 mature leaves per plant. The leaves contain white milk latex. Nakasone (1998). The leaf contains beta-carotene, calcium, carpaine, fats, flavonols, niacin, papain,

tannins and vitamins c (in higher concentration in the leaf than in the fruit). The leaf unlike the fruit is not a source of protein-dissolving enzyme papain but the latex (sap) in the leaf stem. Nakasone (2009).

Flowers

Papaya flowers are born in florescences which appear in the axil of leaves. It can be female, male or hermaphrodite (bisexual) flowers. Female flowers are held close against the stem as single flowers in cluster of 2-3 flowers. Males flowers are smaller and more numerous. Hermaphrodites (perfect) flowers are intermediate between the female and male Nakasone and Paull (1998).

Fruits

The papaya fruits is pear shape with bright-golden yellow skin. The flesh of the fruit is a brighter orange-yellow, juicy and silky smooth with a sweet and sour flavor. The shiny gray or black seeds in the interior of the fruit have a peppery taste and are edible although they are usually disordered. Morton, (1987).

Seeds

Seeds are numerous in central cavities, rounded, blackish, about 0.6cm in diameter, each enclosed in a gelatinous membrane (aril). (Mortan, 1987)

Roots

The papaya root is predominately a non-axial, fibrous system, composed of one or two 0.5-1.0m long tap roots. Secondary roots emerge from the upper sections and branch profusely. Jimenez (2013).

2.7 PHAMACOLOGICAL USES AND ACTIVITY OF CARICA PAPAYA:

Whole *Carica papaya* has a unique pharmacological uses: Aravind, Debjit et al, (2013).

Leaves

Papaya leaves has a numberless of benefits. In some parts of Asia, the young leaves of the papaya are steamed and eaten like spinach.

a. Dengne Fever

Commencing on studies of Dr. Sanath Hettige, who conducted the research on 70 dengue fever patients said papaya leaves juice helps increase white blood cells and platelets, normalizes clothing, and repair the liver Aravind, Debjit (2013).

b. Cancer cell growth inhibition

Recent research on papaya leaf tea extract has demonstrated cancer cell growth inhibition. It appears to boost the production of key signaling molecules called The I –type cytokines, which help regulate the immune system. Aravind, Debjit (2013).

c. Antibacterial and antiplasmodial activity.

Papaya leaves are made into tea as a treatment for malaria.

d. Facilitate digestion

The leaves of papaya plants contain chemical compound of karpain, substance which kills microorganism that often interfere with the digestive function. Aravind, Debjit (2013)

Seeds

The black seeds of papaya are edible and have a sharp spicy taste. They are sometimes grand and used as a substitute for black pepper. Aravind, Debjet (2013).

a. More Potency

The papaya seeds are very pungent and peppery, making them almost unpalatable. However the seeds seem to have more potent medicinal values than the flesh. Aravind, Debjit (2013)

b. Papaya seeds have antibacterial properties and are effective against *Escherichia coli, Salmonella and staphylococcus* infections.

c. Papaya seeds help detoxify the liver.

Roots

Juice from papaya roots is used in some countries of Asia to ease urinary troubles. Papaya leaf when dried and cured like a cigar, is smoked by asthmatic persons. An infusion of fresh papaya leaves is used by person to expel or destroy intestinal worms. Aravind, Debjit (2013)

a. Diuretic

aqueous root extract of papaya when given orally at a does of 10mg/kg to rats produce significantly increase in urine output and shows similar profiles of urinary electrolyte excretion of that of Hydrochlorothiazide. Krishna, Paridhavi (2008).

b. Female ant fertility

Normal consumption of ripe papaya during pregnancy may not pose any significant danger. However, the unripe of semi-ripe papaya (which contains high concentration of the latex that produces marked uterine contractions) could be unsafe in pregnancy. Krishna, Paridhavi (2018)

Latex

The milky sap of unripe papaya contains papain and chymopapain. Chymopapain was approved for intradiscal injection in patients with document hermiated lumbar intervetebra discs and who had not responded to “conservative therapy. Vitamins and traces of an alkaloid called carpaine have also be found in the latex. Papain is

also used to treat commercial beer, to degum natural silk, as a meat tenderizer and in the production of chewing gums. Cosmetically it is used in shampoos and in a number of face lifting operations. In humans, carpaine show down the heart and thus reduces blood pressure. Aravind, Debjit (2013).

Fruits

Papaya fruits is a rich source of nutrients such as provitamin a carotenoids, vitamin C, B vitamins, lycopene, dietary minerals and dietary fiber Aravind, Debjit (2013).

a. Laxative

Ripe papaya fruit is taxative which ensures regulate bowel movement.

b. **Ingestion**

The milky juice which is tapped from the green matured fruit while still in the tree contains an enzymes known as “papain” used in the preparation of different remedies for indigestion. Aravind, Debjit (2013).

Peel

Papaya peel is often used in cosmetics. The papaya peel can also be used in many home remedies. Aravind, Debjit (2013).

a. Sunscreen and soothing slave
b. Fight dandruff
c. Muscle relaxant

2.8 ECONOMIC IMPORTANCE OF CARICA PAPAYA

1. Papaya is mainly cultivated for its edible fruits as a fresh fruit and for use of drinks, jams candies and dried fruit.
2. Ripe fruits are usually eaten fresh and green fruits are also used as a cooked vegetable.

Industrial uses of *Carica papaya* are;

3. Biochemically, it leaves and fruits produce several proteins and alkaloids with important medical and industrial application
4. The latex of green fruits contain a proteolytic enzyme papain used in the beverage and food.
5. It is also used in comestic industries for the production of soap, shampoos etc.

2.9 ALLERGIES, SIDE EFFECTS AND TOXICITY OF PAPAYA

Papaya is frequently used as hair conditioner, but should be used in small amounts. Papaya releases a latex fluid when not quite ripe, which can cause irritation and provoke allergic reaction in people. The latex concentration of unripe papaya is speculated to cause uterine contractions, which may lead to miscarriage. Excessive consumption of papaya can cause carotenemia, the yellowing of soles and palms which otherwise is harmless. Aravind (2013).

2.10 NUTRITIONAL VALUE OF CARICA PAPAYA

Papaya is a wholesome fruit. Papaya has more carotene compare to other fruits such as guava, apples, sitaphal and plaintains. Jimenez, (2013). The fruit in 100grams contains protein (1.0g), carbohydrate (13.5g) and fibre (0.5g). Papaya is rich is iron and calcium; a good source of vitamins A, B and G and an excellent source of vitamin C (ascorbic acid). The extracts of unripe *Carica papaya* contain terpenoids, alkaloids, flavonoids, carbohydrate, glycoside, saponins, and steroids. These nutritional values of papaya help to prevent the oxidation of cholesterol. Aravind, (2013). Unripe green papaya is used as vegetable, it does not contain carotene but also all other nutrients are present. The fruit is a rich source for different types of enzymes, papain, vegetable pepsin present in good amount in unripe fruit is an excellent aid to digestion which helps to digest the protein in food at acid, alkaline and neutral medium. Aravind, (2006).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Sterilization of Materials

All glass wares were first washed with detegent and rinsed with distilled water, wrapped with aluminum foil after drying and sterilized by dry heat method in the oven at a temperature of 160^{o}c for 2-3hrs.

3.2 Disinfection of Working Area

The working area were disinfected thoroughly before and after use with ethanol (75% v.) cotton wool was soaked in ethanol and used to clean the working bench; a Bunsen burner was put on and the flame was allowed to burn, this helped in sterilizing the air in the laboratory.

3.3 Collection and Identification of Plant Materials

Fresh leaves of Papaya plant (*Carica papaya*) were collected in a clean polyethylene bag from Auchi in Etsako West Local Government Area of Edo State. It was identified and authenticated by a plant taxonomist in the Department of Science Laboratory Technology (Biology/Microbiology Option) Auchi Polytechnic, Auchi after which it was transported to the microbiology laboratory of Auchi polytechnic, Auchi for analysis.

3.4 Preparation of Plant Materials

Fresh leaves of Papaya plant (*Carica papaya*)were collected, identified, washed and dried under room temperature: the plant samples were dried under room temperature. The dried samples were blended using a blender, and soak the blended plant with an appropriate solvent for a few days until completely covered the plant material (Omojosola and Awe, 2004). The container is then closed and kept for at least three days.

3.4 Extraction of Plant Materials

3.4.1 Methanol Extract

10g powdered leaves of Papaya plant (*Carica papaya*) was weighed and soakedin 100mls of methanol to completely covered the plant material, the container was closed and kept for at least three days. The mixture was shaken from time to time to ensure complete extraction. At the end of extraction, the mixture was separated by filtration. Subsequently, the filtrate is subjects to rotary evaporation using the rotary evaporator at an appropriate temperature depending on the solvent used for extraction Romasi (2012).

A **Rotary Evaporator** evaporates solvents from samples by utilizing the principle that the solvent will have a lower boiling point at a reduced pressure. Specifically speaking, the step less speed regulation is adopted to make the evaporation flask rotate at a constant speed. By the rotation, materials can form a large area of uniform thin film on the inner wall of the flask. The evaporation flask

is heated evenly by water or oil bath, and materials, with a lower boiling point, is evaporated rapidly under the vacuum condition. The solvent steam is recycled in the receiving flask after being cooled by the high efficiency glass condenser leaving the extract.

3.4.2 N-hexane Extract

10g powdered leaves of Papaya plant (*Carica papaya*) was weighed and soakedin 100mls of N-hexane to completely covered the plant material, the container was closed and kept for at least three days. The mixture was shaken from time to time to ensure complete extraction. At the end of extraction, the mixture was separated by filtration. Subsequently, the filtrate is subjects to rotary evaporation using the rotary evaporator at an appropriate temperature depending on the solvent used for extraction.

A **Rotary Evaporator** evaporates solvents from samples by utilizing the principle that the solvent will have a lower boiling point at a reduced pressure. Specifically speaking, the step less speed regulation is adopted to make the evaporation flask rotate at a constant speed. By the rotation, materials can form a large area of uniform thin film on the inner wall of the flask. The evaporation flask is heated evenly by water or oil bath, and materials, with a lower boiling point, is evaporated rapidly under the vacuum condition. The solvent steam is recycled in the receiving flask after being cooled by the high efficiency glass condenser leaving the extract.

3.5 Source of Test Organisms

Slants of identified microorganisms that had already been characterized and identified were collected from the Microbiology Laboratory of Auchi Polytechnic Cottage Hospital and taken to the Microbiology Laboratory of the Department of Biological Science Laboratory Technology, Auchi Polytechnic Auchi where they were treated with different extracts of leaves of Papaya plant (*Carica papaya*). The identified organisms were: *Staphylococcus aureus* and*Escherichia coli.*

3.6 Culture Media

The media used in this study is Nutrient Agar and the media was prepared according to manufacturer's specification.

3.6.1 Preparation of Nutrient Agar

28g of nutrient agar powder was weighed using a weighing balance and dispensed into a beaker; 1000mls of distilled water was measured using a measuring cylinder and dispensed into the beaker containing the agar powder; it was stirred to dissolve for 10mins. The mixture was transferred into a conical flask and the neck of the flask was corked with cotton wool wrapped in aluminum foil. It was autoclaved at a temperature of 121^{o}c and pressure of .15psi for 15-20minutes.the sterilized agar was allowed to cool to about 45^{o}c and then aseptically poured into Petri dishes and allowed to set Cheesbrough, (2008).

3.7 Antibacterial Sensitivity Testing

The agar diffusion and disc diffusion methods were used in the Antibacterial Sensitivity Testing. The antimicrobial sensitivity test was carried out using the methods modified by Isu and Onyeagba (2002). Molten sterile nutrient agar were poured into different petri dishes. After solidification cultures of bacteria were introduced into the surface of the sterile nutrient agar plate and a sterile glass spreader was used for even distribution. Holes were made aseptically with a sterile cork-borer of 5 mm in diameter and 0.2 ml of different extracts of Papaya plant (*Carica papaya*)was introduced into the well. The bacteria plates were incubated for 24 hours at 37°C.

On the other hand, sterile filter paper were cut and soaked in the different extracts and these were placed on top of the inoculated plates and the plates were incubated at 37°C for 24 hours. The plates containing the controls were incubated also. (The controls were inoculated but the extracts were not added either as agar well or as disc).

The plates were examined after 24hours for zones of inhibition, which indicated the degree of susceptibility of the test organisms.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Results

The result for Antimicrobial activity of paw paw leaf (*Carica papaya*) Extract against *Escherichia coli* and *Staphylococcus aureus* are presented in the table below.

Table 1. Mean zone of inhibition (mm) of extracts of leaves of Papaya plant (*Carica papaya*) on *Escherichia coli* and *Staphylococcus aureus.*

		Extracts		
Isolates	Methods	Methanol Extracts	N-hexane Extracts	Methanol + N-hexane Extracts
Staphylococcus aureus	Agar diffusion	6.0mm	_	8.0mm
	Disc diffusion	_	_	_
Escherichia coli	Agar diffusion	_	_	5.0mm
	Disc diffusion	_	_	_

4.2 Discussions

The antibacterial activity of paw paw(*Carica papaya*) leaves extracts on some human pathogenic microorganisms (*Escherichia coli* and *Staphylococcus aureus*)explains their use in native medicine for the treatment of bacterial infections. The Gram positive bacteria (*S. aureus*) were more sensitive to the methanol extracts as well as a combination of both methanol and N-hexane extracts, compared to the Gram negative bacteria (*Escherichia coli*). This agrees with the observation made by some researchers that plant extracts show considerable activity against Gram positive bacteria than Gram negative bacteria Nostro*et al.,* (2000).

The use of plant extracts to treat diseases has stood the test of time Anwannil and Atta, (2006), more than 75% pure compounds derived from higher plants are used in modern medicine and *Carica papaya*is well known in complementary medical practice in treatment of several ailments.

The result of this research shows that a combination of N-hexane and methanol extract proved more active with a mean zone of inhibition of 8mm on *Staphylococcus aureus*while the sole extract of methanol showed a zone of inhibition of 6mm using the agar diffusion method.

Interestingly, *Escherichia coli* was resistant to single extracts of N-hexane and methanol extract but was susceptible to a combination of N-hexane and methanol extract with a zone of inhibition of 5mm which proves that synergistic therapy sometimes are more effective when compared to sole extraction method.

The result also showed that the agar diffusion method is more effective when compared to the disc diffusion method since there was no antibacterial activity when the disc diffusion method was used.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

It could be however concluded that the demonstration of antimicrobial activity against both gram-negative and gram-positive bacteria is an indication that the plant is a potential source for production of drugs with a broad spectrum of activity.

The results of the study also supports the use of different solvents in the extraction of phytochemicals from plant extracts possess compounds with antibacterial properties that can be used as antibacterial agents in novel drugs for the treatment of gastroenteritis, and wound infections.

5.2 Recommendations

Some antibiotics have been obsolete because of the problem of drug resistance, thus improvement of health using herbs as raw materials should be reconsidered.

Further pharmacological evaluations, toxicological studies and possible isolation of the therapeutic antibacterial from this plant are the future challenges.

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