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RESEARCH ARTICLE

# ANTIMICROBIAL ACTIVITY, CHEMICAL COMPOSITIONS AND PROXIMATE ANALYSIS OF *IXORA COCCINEA* L. LEAVES ON SOME CLINICAL PATHOGENS

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**ABSTRACT**

Plants derived bioactive compounds have been the centre of recent research owing to their health promoting effects. An attempt was made in evaluating the phytochemical, minerals, proximate and anti-microbial activity of *Ixora coccinea* L. The phytochemicals, minerals and proximate analyseswere investigated using standard methods. Anti-microbial activity was determined by standard agar well diffusion method. The phytochemical analysis revealed the presence of alkaloids, saponins, tannins, flavonoids, cardiac glycosides, oxalate, phenol, anthraquinone and phytate. The minerals analysis revealed the presence of sodium, potassium, calcium, magnesium, zinc, iron, copper, manganese and phosphorus. Highest mineral content was recorded in magnesium (21.65 mg/100g). Proximate analysis showed the presence of ash (10.3%), moisture (7.10%), protein (16.45%), fat (6.10%), fibre (10.99%) and carbohydrate (40.20%). The antimicrobial analysis revealed the activity of the plant against *Staphylococcus aureus, Bacillus subtilis, Samonella typhi, Escherichia coli* and *Pseudomonas aeruginosa*. It showed its highest potency against *Pseudomonas aeruginosa.* The results showed that substantial amounts of nutrients, minerals and phytochemicals present in *I. coccinea* leaves would contribute greatly to the human nutritional requirements and give adequate protection against various diseases associated with the tested organisms.



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## INTRODUCTION

For a long period of time, plants have been a cherished source of natural products for sustaining human health,particularly in the last decade, with more thorough studies for natural therapies. They formed the main of traditional medicine amid the rural inhabitants worldwide since the inception of civilization (Dutta *et al.,* 2013). In Nigeria, majority of the citizens still use medicinal floras and visit traditional medicine practitioners for their well-being care need (Odugbemi, 2006). Over the years, plant resources have been subjected to numerous screening to authenticate their applauded therapeutic values as interest in therapeutic plants is now on the rise with the aim of achieving substitute for the excessive cost of prescription drugs in view of upholding personal health and well-being as well as the bio-prospecting of new plant-derived pills.

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Deriving potential benefits from plants has always been a field of speculation for researchers and has made the basis for development of drugs to treat countless ailments. Hence forth, screening of plants for the occurrence of natural products and valuable properties presents a mainpath. Medicinal plants, particularly those with anti-infective properties are broadly used in Africa owing to their availability and ease of access; additionally, lack of access to modern medicine in rural societies has made traditional medicinal practice the only choice in fighting illnesses. Such plants could likewise serve as sources of new antimicrobial and other medicines (Akinyemi *et al.,* 2005). The use of plant extracts and phytochemicals, both with identified antimicrobial properties, can be of great importance in therapeutic managements. In the last few years, a number of studies have been conducted in different countries to ascertain such effectiveness (Shapoval *et al.,* 1994; Sousa *et al.,* 1991**).** Several plants have been used due to their antimicrobial potentials, which are owing to compounds synthesized in the secondary absorption of the herb. Several plant extracts and the phytochemicals gotten from them have revealed activities against all types of microorganisms including Gram positive and Gram negative bacteria (Nascimento *et al.,* 2000). *Ixora coccinea L.* is used traditionally for a variety of diseases and also cultivated for ornamental purposes. The roots of the plant *I. coccinea* are commonly used as an astringent, antiseptic, stomachic, sedative etc. Traditionally, roots are also used in treating diarrhoea, dysentery, gonorrhoea, loss of appetite, hiccups, fever, sores and chronic ulcers. Flowers are mostly used in haemoptysis, leucorrhoea, dysentery, dysmenorrhoea and catarrhal bronchitis. Decoction of the flowers or bark is used as a lotion for eye dilemmas (Khare, 2007). Preclinical studies have revealed that the plant have antimicrobial, anti-inflammatory, anti-nociceptive, anti-oxidant, anti-ulcerogenic, hepatoprotective, antidiarrheal, anti-mutagenicity and hypolipidaemic activities (Baliga and Kurian, 2012). The therapeutic efficacy of these herbs has mainly been ascribed to the occurrence of various phytochemicals such as vitamins, minerals, phenolic acids, tannins, lignin, stilbene, flavonoids, terpenoids, quinones, alkaloids, amines, coumarins, betalains, and other secondary metabolites. Studies have proved that many of these phytochemicals contribute as antitumor, anti-inflammatory, antiviral agents, antioxidants, antimutagenic, anti-carcinogenic, anti-atherosclerotic and antibacterial (Sala *et al.,* 2002). Hence, interest in medicinal plants is now on the rise with the aim of getting substitute for the exorbitant cost of prescription drugs in view of sustaining personal health and well-being as well as the bio-prospecting of new plant-derived drugs. This research was therefore aimed at the elucidation of the various phyto-constituents, nutritional components and antimicrobial properties embedded in the leaves of *I. coccinea*.

## MATERIALS AND METHODS

**Plants Materials:** The leaves of *Ixora coccinea* were plucked from Ibadan, Oyo State, Nigeria and identified by a certified botanist at the herbarium unit of the Department of Plant science and Biotechnology, Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria.

**Preparation of plant extracts for Extraction:** The leaves were gently and thoroughly washed with sterile distilled water to avoid any form of contamination, and then air-dried at room temperature for about two weeks to ensure that the samples lose most of their moisture content. The extractions were carried out using ethanol. 250g of dried leaves were weighed into conical flasks containing 750ml of ethanol; the mixtures were initially shaken rigorously and left for 9 days. The mixtures were later filtered using sterile What man filter papers and the filtrates were collected directly into sterile crucibles. Filtrates obtained were introduced into sterile reaction tubes and heated continuously in water bath at the $78^{O}$Cethanol. The residues obtained were kept at room temperature (Osuntokun, 2015).

**Phytochemical, mineral and proximate analyses:** Qualitative and quantitative phytochemical tests were conducted on the leaves of *Ixora coccinea*by using standard methods adopted by Sofowora (1993), Oyoyede (2005), Ogboru *et al.* (2015) and Owoeye *et al.* (2016) for the presence of tannins, saponins, flavonoids, cardiac glycosides, phenols, alkaloids, steroids, anthraquinones and phytate. The mineral and proximate compositions of the leaves extract were evaluated by the methods of Oluduro (2012).

**Clinical microorganisms:** Pure cultures of five species of human pathogenic bacteria; *Staphylococcus aureus, Bacillus subtilis, Samonella typhi, Escherichia coli* and *Pseudomonas aeruginosa*were obtained from Obafemi Awolowo University, Ile-Ife, Osun state, Nigeria. They were isolated on sterile nutrient agar slants and taken to the microbiology laboratory of the Adekunle Ajasin University, Akungba Akoko, Nigeria. All slants of test organisms were kept at -4$^{o}$C prior to bioassay of the extract. Extensive biochemical tests were carried out to further confirm all the test bacterial strains (Osuntokun and Olajubu 2014; Barrow and Feltham, 1995).

**Standardization of Inoculum:** Slants of the various organisms were reconstituted in an aseptic condition. A sterile wire loop was used to transfer approximately one isolated colony of each pure culture into 5ml of sterile nutrient broth and incubated for 24 hours. After incubation, 0.1ml of the isolated colony was introduced with a sterile needle and syringe into 9.9ml of sterile distilled water in each test tube and then mixed properly. The liquid served as a source of inoculum containing approximately $10^{6}$cfu/ml of bacterial suspension (El-Astal 2005).

**Antimicrobial assay:** Antibacterial assay for *Ixora coccinea* Lethanol leaves extract was carried out by agar well diffusion technique. All the test organisms were sub-cultured onto sterile Mueller Hinton Agar plates and incubated at 37$^{0}$C for 18-24h. Five distinct colonies of each organism were inoculated onto sterile Mueller Hinton broth and incubated for 3-4h. All innocula were standardized accordingly to match the 0.5 McFarland standards and this standard was used for all susceptibility tests. The ethanol extract was reconstituted into dimethyl sulphoxide (DMSO) to obtain the following concentrations: 60mg/ml, 30mg/ml, 15mg/ml and 7.5mg/ml; using. The susceptibility test was investigated by the agar-well diffusion method.0.1 ml of 1:10,000 dilutions (equivalent to $10^{6}$cfu/mL) of fresh overnight culture of the clinical isolates grown on Muller Hinton agar and potato dextrose agar was seeded into 40 mL of Muller Hinton agar, and properly mixed in universal bottles. The mixture was aseptically poured into sterile petri dishes and allowed to set. Equidistant wells were made in the agar with a sterile cork borer of 4 mm diameter. Drops of the re-suspended, (2ml per well) extract with concentrations between 60mg/ml to 7.5 mg/ml were introduced into the wells. Ciprofloxacin and Metronidazole (2mg/ml each) were used as the control experiment. The plates were allowed to stand on the bench for an hour, to allow pre-diffusion of the extract before incubation at 37$^{o}$C for 24 hours. The zones of inhibition were measured to the nearest millimeter (mm) using a standard transparent meter rule. All experiments were performed in duplicates (Ayodele 2014).

## RESULTS

The qualitative screening of phytochemicals present in the ethanol leaves extract of *Ixora coccinea* is presented in Table 1. The phytochemical study revealed the presence of alkaloid, cardiac glycoside, anthraquinone, tannin, saponin and flavonoid while steroid and phenol were absent. Table 2 shows the quantitative estimation of phytochemicals present in the leaves extract of *Ixora coccinea*. A considerable amount of tannins, phenol, phytate, oxalate, saponin, flavonoids and alkaloid were present with phenol recording the highest value (17.30%), followed by oxalate (12.89%), the least value were found in flavonoid (1.23%).

**Table 1. Qualitative screening of phytochemicals present in the ethanol leaves extract of *Ixora coccinea*L.**

| | |
|---|---|
| Alkaloid | + |
| Cardiac glycoside | + |
| Steroid | - |
| Anthraquinone | + |
| Phenol | + |
| Tannin | + |
| Saponin | + |
| Flavonoids | + |

KEY: + = present, - = absent

**Table 2. Quantitative estimation of phytochemicals present in the Ethanol leaves extract of *Ixora coccinea* L**

| Phytochemical Constituent | Amount present (%) |
|---|---|
| Tannin | 3.50 |
| Phenol | 17.30 |
| Phytate | 3.69 |
| Oxalate | 12.89 |
| Saponin | 7.53 |
| Flavonoid | 1.23 |
| Alkaloid | 3.20 |

**Table 3. Elemental composition of *Ixora coccinea* leaves**

| Elements | Amount (mg/100g) |
|---|---|
| Sodium | 10.29 |
| Potassium | 18.56 |
| Calcium | 11.70 |
| Magnesium | 21.65 |
| Zinc | 19.55 |
| Iron | 6.79 |
| Lead | ND |
| Copper | 0.02 |
| Manganese | 16.32 |
| Phosphorus | 9.45 |

KEY: ND = Not Detected

**Table 4. Proximate composition of *Ixora coccinea* leaves**

| Parameters | Amount (%) |
|---|---|
| Ash | 10.3 |
| Moisture content | 7.10 |
| Crude protein | 16.45 |
| Crude fat | 6.10 |
| Crude fibre | 10.99 |
| Carbohydrate | 40.20 |

**Table 5. Antimicrobial activity of *Ixora coccinea* leaves**

| Test Microorganisms | Concentrations of the plant (mg/ml) | | | | |
|---|---|---|---|---|---|
| | Control | 60 | 30 | 15 | 7.5 |
| *Staphylococcus aureus* | 21 | 12 | 9 | 5 | 3 |
| *Bacillus subtilis* | 22 | 15 | 12 | 8 | 5 |
| *Samonella typhi* | 21 | 16 | 10 | 7 | 4 |
| *Escherichia coli* | 20 | 10 | 7 | 5 | 3 |
| *Pseudomonas aeruginosa* | 22 | 16 | 12 | 10 | 7 |

Elemental compositions present in the ethanol leaves extract of *Ixora coccinea* is tabulated in Table 3. The existence of essential minerals and their contents levels analyzed showed that *Ixora coccinea* contains sodium (10.29 mg/100g),potassium (18.56 mg/100g), calcium (11.70 mg/100g), magnesium (21.65 mg/100g), zinc (19.55 mg/100g), iron (6.79 mg/100g), copper (0.02 mg/100g), manganese (16.32 mg/100g) and phosphorus (9.45 mg/100g) respectively. Lead was not detected. Table 4: Proximate composition of *Ixora coccinea* leaves is presented in Table 4.Proximate study revealed that the leaves contain little nutrients. Macro nutrient like protein and carbohydrates were determined with value of 40.20% and 16.45% respectively. Other macro nutrients were also relatively high in content level. Crude fat had a small content level of 6.10%. Proximate analysis for crude fibre, ash, and moisture also revealed their contents levels to be 10.99%, 10.3% and 7.10% respectively (Table 4). The antimicrobial activities of the ethanol leaves extract of *I. coccinea* were studied and the result of the study was given in the Table 5. The extract in which four concentrations (60mg/ml, 30mg/ml, 15mg/ml and 7.5mg/ml) were tested against five bacterial strains were found to possess antimicrobial activity against the tested bacteria; *Staphylococcus aureus, Bacillus subtilis, Samonella typhi, Escherichia coli* and *Pseudomonas aeruginosa*. It was interesting to note that the plant extract showed antimicrobial activity against all the tested microorganisms. The highest antimicrobial activity was observed against *Pseudomonas aeruginosa.* An increase in the concentration of the plant extract led to an increase in the zone of inhibition. Gentamicin (20 mg/ml) were used as standard in this experiment and showed significant antimicrobial activity against all the tested bacteria. In *Pseudomonas aeruginosa,* the concentrations inhibited more zone than the other tested organisms.

## DISCUSSION

Phytochemical investigation carried out on the *Ixora coccinea* ethanol leavesextract showed the presence of components which are known to exhibit medicinal as well as biological activities. Analysis of the plant extract revealed the presence of phytochemicals such as saponins, phenols, anthraquinone, tannins, flavonoids, cardiac glycosides, phytate, oxalate and alkaloids. Natural antioxidant mostly comes from plants in the form of phenolic compounds such as tocopherols, flavonoid, phenolic acids, etc. (Deshpande and Kadam, 2013). Phenolic compoundshave biological properties such as anti-carcinogen, anti-atherosclerosis, cardiovascular protection, anti-aging, anti-inflammation, improvement of endothelial function and apoptosis, as well as cell proliferation activities and suppression of angiogenesis (Han *et al.,* 2007). Tannins are acerbic bitter plant polyphenolic compound of high molecular weight that binds to and precipitates proteins and numerous other organic compounds including amino acids and alkaloids (Dutta *et al.,* 2013). Tannins have been known generally as anti-nutritional but it is now identified that their beneficial properties be liable upon theirdosage and chemical structure. Flavonoids are vital constituent in modifiable control of development in some plants and their unfavorably effect on insect nourishing (Nagarajan and Sellamuthu, 2013). The capacity of flavonoids is owing to their ability to intricate with extracellular and soluble proteins and to complex with bacterial cell wall (Marjorie, 1996). Flavonoids are also active antioxidant and show tough anticancer activities (Salah *et al.,* 1995). Ojokuku *et al.* (2010) pointed out that flavonoids have been shown to have antibacterial, anti-thrombotic, anti-allergic, anti-inflammatory, antimutagenic, antioxidant, antineoplastic, and antiviral activities. *Ixora coccinea* ethanol leaves extract also showed the presence of saponins which are known to produce inhibitory effect on soreness (Just *et al.,* 1998). Saponins have the property of coagulating and precipitating red blood cells. Some of the features of saponins include hemolytic activity, cholesterol binding properties, bitterness and formation of foams in aqueous solutions (Sodipo *et al.,* 2000). Anthraquinones components support the plant usefulness in the management and therapeutic applications as arrow poisons or cardiac drugs as laxatives. The occurrence of anthraquinones was stated to have anti-tumor activities, antimalaria, antimicrobial, anti-viral and anti-oxidant activities. Glycosides are known to lower the blood pressure agreeing to several reports (Nyarko and Addy, 1990). Bandyopadhyay *et al*. (2002) referred to glycosides as the main bioactive constituent that offers anti-ulcerative and anti-secretory effects. Plant glycosides, which are not normally lethal when ingested orally, are known to prevent chloride passage in the stomach. Alkaloids have been linked with therapeutic consumptions for eras and one of their common biological properties is their cytotoxicity (Okwu and Okwu, 2007). Numerous authors have stated the antispasmodic, antibacterial (Stray, 1998) and analgesic (Nobori *et al.,* 1994) properties of alkaloids. Several Alkaloids are pharmacologically active constituents having various pronounced physiological activities, such as vincristine and vinblastine as antitumor agents, quinine as anti-malarial agent and reserpine as anti-hypertensive, which has brought them into computation. Phytochemicals recorded in this study corroborate with the findings of Annapurna *et al.* (2003), who confirmed the presence of flavanoids, alkaloids, steroids, saponins and terpenes from the ether extract of *I. coccinea*. Also, presence of phenols, steroids and alkaloids were confirmed from the plant's methanol extract. Absence of a particular phytochemical in some plants can be ascribed to the several physiological and biosynthetic reactions taking place in the plant, the role environment plays should not be ignored as the environment always alter or modify their components. Among the minerals, iron is considered as an indispensable as it provides energy and supplies oxygen. Iron is considered acrucial mineral because it is required to make haemoglobin, a part of blood cells. From this study, the iron content in the leaves of *I. coccinea* was 6.79 mg/100g which was higher than *Aporosa cardiosperma* (1.78 mg/100g), *Elaeocarpus tectorius* (4.16 mg/100g) and *Syzygium jambos* (1.22 mg/100g) reported byAbhishek *et al.,* (2017).Deficiency of iron may lead to anaemia (Cook, 2005). Excessive accumulation of iron can result to grayish colour of the skin, anorexia, vomiting and nausea (Institute of Medicine, 2001).

Potassium is also a vital mineral because of its water balance role in the body while sodium plays an important role incarrying of metabolites. Atherosclerosis has been an underlying mechanism of heart ailments (Singh *et al.,* 2003) and the consumption of natural herbs has been suggested by Ayuveda for the management of heart ailments (Saxena and Vikram, 2004). The potassium content reported in this study was 18.56 mg/100g. Compared to other medicinal plants such as *Indigofera astragelina* leaves (14.55 mg/100g) (Gafar *et al.,* 2011) and *Securinega virosa* leaves (3.67 mg/100g) (Uzama *et al.,* 2012), *I. coccinea* leaves contained highest potassium content (18.56 mg/100g). The recommended safety limit for potassium is set amid 10-100 μg/g (WHO, 1996). The leaves of *I.* coccinea gave moderate source of sodium (10.29 mg/100g) which could help lower blood pressure, amino acid, energy production and glucose conveyance into the body cells. The body uses sodium to regulate acid-base balance blood volume and control blood pressure. The body also needs sodium for nerves and muscles to work properly. This amount is slightly lesser than the amount found in *Buchanania cochinchinensis* (21.22 mg/100g), *Pithecellobium dulce* (12.45 mg/100g) and *Carissa spinarum* (33.77 mg/100g) reported by Abhishek *et al.,* (2017), but higher than 0.02 mg/100g found in *Aspilia africana* and *Bryophyllum pinnatum* (Okwu and Josiah, 2006). However, excess of sodium in the diet may result in high blood pressure in some people, a serious buildup of fluid in people with congestive heart failure, kidney disease or liver cirrhosis (Aronow *et al.,* 2011). The recommended safety limit for sodium is set at 0.4-0.5 mg/g (WHO, 1996). Zinc, an important trace element in diet, serves as an integral part of numerous enzymes such as superoxide dismutase (Ozturk *et al.,* 2003) or as a stabilizer of the molecular structure of sub-cellular components and membrane. It participates in the synthesis and degradation of nucleic acids, protein, lipids and carbohydrates (Uzama *et al.,* 2012); also shown to play an important role in polynucleotide transcription and translation and thus in the process of genetic expression, influences healing and tissue growth; and participates in insulin production (Hamid *et al.,* 1998) and spermatogenesis (Serfor-Armah *et al.,* 2002). The recommended safety limits for zinc is 0.15-20 mg/g (WHO, 1996). The zinc content of *I. coccinea*leaveswas 19.55 mg/100g which is more than the content in *Mucunasloanei* (0.25 mg/100g), *I. astragelina* leaves (0.11 mg/100g) (Gafar *et al.*, 2011); *Semecarpus anacardium* (0.16 mg/100g) and *Carissa spinarum* (0.57 mg/100g) (Abhishek *et al.,* 2017). Magnesium aids to sustain normal muscle and nervefunction, keeps the heart beat steady, supports a healthy immune system, and aids bones remain strong. It also aidscontrol of blood glucose levels and help in the production of protein and energy. Deficiency of magnesium may lead to severe complaints such as cardiovascular ailments, hypertension and diarrhoea (Swaminathan, 2003). The magnesium content in this study was 21.65 mg/100g which was more than *Syzygium jambos* (4.93 mg/100g), *Opuntia dillenii* (10.73 mg/100g) and lowered than *Aporosa cardiosperma* (42.52 mg/100g) and *Spondias pinnata* (31.37 mg/100g) (Abhishek *et al.,* 2017).

Despite being a micro-element, manganese significance to human well-being cannot be overemphasized. Manganese activates numerous enzymes such as decarboxylases, kinases, transferases and hydrolases. It functions as a cofactor to different enzymes like mitochondrial superoxide dismutase and pyruvate decarboxylase (an enzyme which catalyzes the conversion of pyruvate to oxalo-acetate)(Bowler *et al.,* 1992). Keen *et al.* (1994) reported the participation of manganese in initiating enzymes involved in insulin metabolism. The leaves of *I. coccinea*is rich in this essential micronutrient (16.32 mg/100g) compared to that of *Securinega virosa* (1.50 mg/100g) (Uzama *et al.,* 2012), *Mucuna sloanei* (0.65 mg/100g), green leafy vegetable (0.98 mg/100g ), and *I. astragalina* leaves (0.43 mg/100g) (Gafar *et al.,* 2011), but lower in *Catharanthus roseus* (37.2 mg/kg) and *phyllanthus amarus* leaves (64.5 mg/kg) (Djama *et al.,* 2012). Calcium is the most abundant mineral found in the human body. The bones and teeth contain mostly calcium. Body tissues, Nerve cells, blood and other body fluids contain the rest of the calcium. Increased calcium for a limited period of time does not normally result in side effects. The calcium content in this study was 11.70 mg/100g which was in the same range with the findings of Abhishek *et al.* (2017) in same plant species, *Ixora coccinea* (11.54 mg/100g) but lower in *Opuntia dillenii* (19.54 mg/100g), *Aporosa cardiosperma* (20.11 mg/100g) and *Semecarpus anacardium* (26.11 mg/100g) (Abhishek *et al.,* 2017). However, receiving higher quantities of calcium over a long period of time increases the threat of kidney stones in some people (Sarubin and Thomson, 2007). Lead is lethal in nature and its present in small amount in several medicinal plant sowing to the contamination arising from automobile and industrial activities. It is a lethal metal and non-essential element for human body instigating kidney and brain damage, rise in blood pressure and nervous system disruption (Khan *et* *al.,* 2011). Lead was not detected in this study, thus this plant can be considered to be relatively safe for use as herbal medicine. One of the most vital compositions of many nutrients is the carbohydrate which is seen as an essential source of energy. Nosiri *et al.* (2011) documented that the carbohydrate content of *Irvingiagabonensis* seeds used in traditional and recent medicine for the management of several diseases was 15.71 to 55.00%. In this study, the carbohydrate content of *I. coccinea* was 40.20% which was higher than that of*Jatropha gossypifolia* 34.18% (Faokunla *et al.,* 2017) but lowered in*Buchanania cochinchinensi* (30.83%), *Phoenix sylvestris* (21.21%) and *Syzygium caryophyllatum* (24.09%)(Abhishek *et al.,*2017). In comparison with the Recommended Dietary Allowance (RDA) of 130g (Nosiri *et al.,* 2011), *I. coccinea* is a moderate source of carbohydrate. The crude protein obtained for *I. coccinea* was 16.45%. Compared to medicinal plants such as Balsam apple and *Momordica foecide* leaves which contained 11.29% and 4.6% of crude protein (Hassan and Umar, 2006), *Opuntia dillenii* (0.88%), *Buchanania cochinchinensi* (1.69%), *Phoenix sylvestris* (2.18%)and *Syzygium caryophyllatum* (3.22%) (Abhishek *et al.,* 2017),*I. coccinea*leaves had a relatively higher percentage of crude protein. The crude fat content of the *I. coccinea* was estimated to be 6.10% which was high when compared with *Jatropha gossypifolia* (Faokunla *et al.,* 2017), *Securinegavirosa* leaves (4.70 %) (Uzama *et al.,* 2012), *Amaranthus hybridus* leaves and spinach leaves (1.60 %) (0.3 %) (Nwaogu *et al.,* 2000), *Aporosa cardiosperma* (0.18%), *Buchanania cochinchinensi* (0.43%), *Semecarpus anacardium* (1.84%) and *Syzygium caryophyllatum* (0.93%)(Abhishek *et al.,* 2017).

Lipid serves as a good source of energy and vital constituent of the bio-membrane layer. Fat soluble vitamins are transported via the help of lipids. Lipids are also known to be insulators as well as defense to internal tissues, helping several cellular processes and signalling systems. However, a food providing 1-2% of its caloric energy as fat is said to be adequate in man, as excess for intake is implicated in certain cardiovascular diseases such as atherosclerosis, cancer and aging (Antia *et al.,* 2006). Ash was the leftover remaining after all the moisture had been removed as well as the organic materials such as carbohydrates, fat, vitamins and protein had been incinerated at a temperature of about $500^0$C. The ash content determined in the leaves of *I. coccinea* was 10.3% showing that the leaves were rich in mineral elements. The ash content in this study was higher compared to the 1.80% reported in sweet potato leaves (Asibey-Berko and Tayie, 1999) and the 5% in *Tribulus terrestris* leaves (Nwaogu *et al.,* 2000), 0.24% in *Aporosa cardiosperma*, 1.45% in *Buchanania cochinchinensi* and 1.41% in *Semecarpus anacardium (*Abhishek *et al.,* 2017) but lowered in some leafy vegetables generally consumed in Nigeria such as *Talinum trangulare* (20%) (Akindahunsi and Salawu, 2005). Result of the crude fibre obtained in *I. coccinea* leaves was 10.99%. This low level is considered suitable, because it helpsin absorption of glucose and fat (Akpabio and Ikpe, 2013). Fibres in the nutrient are needed for easy digestion and effective waste removal (Okwu, 2006). Usefulness of fibres in lowering hypertension, risk of coronary heart disease, serum cholesterol level, breast cancer, constipationand diabetes has been reported (Vadivel and Janardhanan, 2005). The low level gotten in this study is in agreement with the observation of Oladiji and Mih (2005) that even though crude fibre improves digestibility, its occurrence in high level can declined nutrient usage and cause intestinal irritation. Diet fibre also helps absorption of trace elements in the gut (Iniaghe *et al.,* 2009). Moisture content depends on the ecological conditions such as temperature, humidity, harvest time,storage conditions and climate. Thus, it is imperative for food scientists to be able to reliably measure moisture contents. The moisture content of *I. coccinea* leaves was shown to be 7.10% which was lower than that of A*calypha huspida* (11.02%), *Acalypha recemosa*(11.91%), *Acalypha maginata* (10.83%) (Iniaghe *et al.,* 2009); *Aneilema aequinoctiale* (84.89%) (Akpabio and Ikpe, 2013); *Jatropha gossypifolia* (24.97%) (Faokunla *et al.,* 2017), *Buchanania cochinchinensi* (63.01%), *Semecarpus anacardium* (78.01%) and *Syzygium caryophyllatum* (66.76%) *(*Abhishek *et al.,* 2017). This revealed a relatively high shelf life for the fresh plant thus long storage of the plant would not lead to microbial degradation. Moisture content is amid the most important and frequently used measurement in the processing, preservation and storage of food (Onwuka, 2005). The reasonably low moisture content ofplants would deter the growth of microorganism and whether storage life would be long (Adeyeye and Ayejuyo, 1994).

Medicinal plant extracts from many studies have shown that plants from similar genera with *I. coccinea* have antimicrobial activity. In this study, the antimicrobial activity of ethanol leaves extract of *I. coccinea* was tested againstsome clinical bacteria (*Staphylococcus aureus, Bacillus subtilis, Samonella typhi, Escherichia coli* and *Pseudomonas aeruginosa*). It was interesting to note that the plant extract in various concentrations showed antimicrobial activity against all the testedbacteria. The antimicrobial activity of the extract was at its peak against *Pseudomonas aeruginosa.* Previous reports showed that the leaves of various species of *Ixora* havesubstantial antimicrobial activities (Annapurna *et al.,* 2003; Latha *et al.,* 2012). Antimicrobial activity recorded in this study was in line with the findings of Saleha *et al.* (2015) who reported that the extract of *I.parviflora* showed strong antimicrobial activity against *Salmonella typhi, Acinetobacter, Salmonella paratyphi* and *Bacillus subtilis*. The antibacterial effects of the methanolic and ether extracts of Ixora leaves were studied at 100 g/ disc *in vitro* by the paper disc method on *Arthrobacter citrus, Bacillus cereus, B. polymixa, B. licheniformis, B. subtilis, Staphylococcus aureus, Clostridium sp, Streptococcus sp, Klebsiella aerogenes, Escherichia coli, Pseudomonas aeruginosa, P. putida, Sarcina lutea, Salmonella typhimurium, Nocardia sp* and antifungal (*Candida albicans* and *Saccharomyces cerevisiae*) (Annapurna *et al.,* 2003).

## Conclusion

Ethanol leaves extract of *I. coccinea* in this study confirmed a broad spectrum of antibacterial activity against the tested bacteria which may be due to the presence of secondary metabolites such as alkaloids, phenols, flavanoids, steroids and saponins identified in the plant. Substantial amount of nutrients: carbohydrates, proteins, fibres, and minerals: iron, potassium, sodium, calcium and magnesium present in *I. coccinea* leaves suggest that if consumed in sufficient amount, it would contribute significantly to the man nutritional requirements and give adequate protection against various ailments. Therefore, it is suggested that further work should be carriedout to isolate, purify and characterize the active constituents accountable for the activity of this plant. Also, additional work is encouraged to clarify the possible mechanism of action of this extract.

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