



## **Anti-microbial and Wound Healing Properties of Leaf Extracts of *Spermacoce verticillata* L**

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### **Authors' contributions**

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## **ABSTRACT**

The Rubiaceae family is one of the most important medicinal families that are found in the tropical region of the world. There are many species under the Rubiaceae family such as *Coffea arabica*, *Cinchona officinalis*, *Spermacoce verticillata*. There are several plant parts used to extract the metabolites from, such as the leaf, bark, root, seed, or fruit. The leaf of *Spermacoce verticillata* has many medicinal values as it contains metabolites which help to reduce microbial activity and help to heal the wound. The microbial activity can lead to skin infections and internal disease. The plant metabolites can act via inhibition of cell wall formation or inhibition of protein synthesis. Wound healing is referred to as the repair of cuts and infections of the human skin. Leaf extracts may help to increase the fibrin formation to clot the blood, and the metabolic compounds may also

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help to reduce the microbial load in the wound to reduce the chance of infection. Plant leaves contain many metabolites that can act as antimicrobial substances for humans such as minimoidiones A, Cytochalasin D, multiforcin I, and xylarenones E.. Some of those factors can disrupt the sequence of wound healing such as factors of controlling blood sugar level which seriously affect the wound healing and external factors such as contamination of microbes in the wound. The wound healing properties of leaf extract help the immune system to fight the microbes which slow down the wound healing process by the release of harmful metabolites.

**Keywords:** Wound healing; Rubiaceae family; Spermacoce verticillata; human body.

## 1. INTRODUCTION

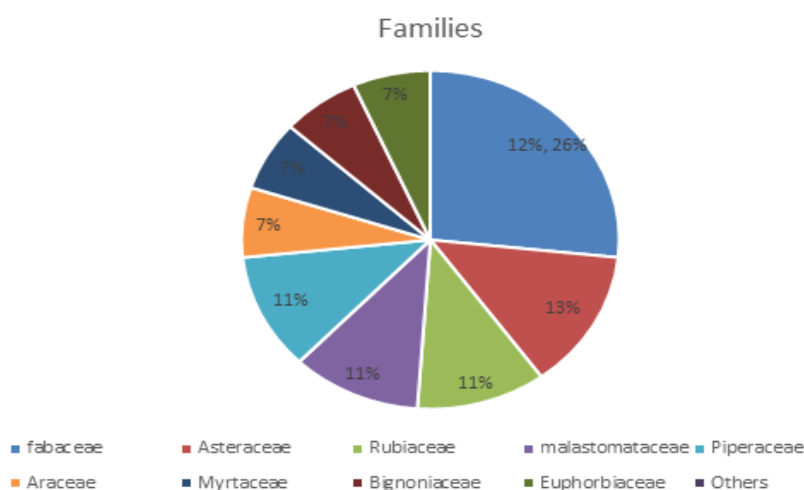
Traditional medicine has wide acceptance in all countries irrespective of its sophistication and development. This type of medicine is popular in rural areas as it has easy access, low cost, fewer side effects, and greater efficiency than any other medicine. *Spermacoce verticillata L.*, also known as the *Borrelia verticillate L.*, is a semi-woody or perennial shrub, it belongs to the family of Rubiaceae. According to the name, this shrub has verticillaster inflorescence. This plant is a type of weed that has many medicinal values. Namukobe et al. [1] stated that western tropical African is the biotope of the plant. This plant can also be found in the tropical regions of Asia and America [1].

The local name of the plant is 'DIOLA eribulin', and the leaf of this plant has more medicinal value than any other part of the plant.

Antimicrobial properties can be defined as the capacity of substances to kill pathogenic microbes in the human body. Wound healing

properties can be defined as the effect to accelerate the wound healing process [2]. The wound healing process requires fast cell regeneration to replace the damaged cells.

The herb Sperm.vert. has the property to propel the fibrin formation that helps the blood to clot in a wound. The leaf extract also has antimicrobial properties that inhibit harmful bacteria to grow in the wound by inhibiting bacterial cell wall formation, protein synthesis, depolarization of the cell membrane, inhibition of nucleic acid synthesis, and inhibition of metabolic pathways of microorganisms. Plants that have been used in African society have various antimicrobial properties against many harmful microorganisms. Ouattara et al. [3] argued that this plant has antimicrobial properties against the pathogens *Staphylococcus aureus*, *Salmonella typhi*, *Escherichia coli*, *Enterobacter sp.*, and *Klebsiella sp.*. Western countries are now depending upon plant-based medicine for their modern medicine, reducing the number of chemicals helping people from side effects of drugs.



**Fig. 1. Importance of plant families in herbal medicine**  
(Source: Influenced by Hussein and El-Anssary)

## 1.1 Literature Review

### 1.1.1 Antimicrobial properties of *Spermacoce verticillata* L.

The human body is the ideal place for all different microorganisms, some of the microorganisms are useful for the human body, and the rest of the microorganisms are harmful to the human body. *Spermacoce verticillata* is an herb that belongs to the family of Rubiaceae, this family has many antimicrobial effects that prevent the microbes from growing in the human body. Microorganisms can be various types such as bacteria, viruses, protozoa, fungi, and many more. Zerroug *et al.* [4] stated the human immune system to be the primary barrier between infection and microorganisms. The Rubiaceae family has an excellent number of antimicrobial activities that help to reduce the microbes load in humans. According to Othman *et al.* [5], the *Spermacoce verticillata* have antimicrobial properties such as antifungal, antiprotozoal, antibacterial activities, for humans such as minimoidiones A, Cytochalasin D, multiforcin I, xylarenones E,.

The Rubiaceae family has a wide range of herbs that all contain medicinal properties, especially in the leaves. Microbes are found everywhere, the effect of mycobacterial activity can be beneficial and can be harmful, and this is mainly caused by the metabolites produced by the microorganism. The production of the harmful metabolism can be reduced or ceased by the activity of metabolites produced by the *Spermacoce verticillata*. Riondato *et al.* [6] stated that many ways can reduce the production of microbial metabolites

such as reducing the effect of metabolites, dissolving the outer membrane of the microbe, dissolving the nucleic acid, and halting the protein synthesis,. Some of the diseases caused by fungi are candidiasis, aspergillosis, blastomycosis,. An example of a metabolite that is found in *Spermacoce verticillata* is 'Cytochalasin D', this metabolite acts as an antifungal drug that inhibits the metabolites of a fungus and hence reduces the effect of the fungus.

### 1.1.2 Wound healing properties of *Spermacoce verticillata* L.

A wound can be defined as an opening or damage to the skin surface. Wounds can be minor cuts, abrasions, bites, surgical wounds. Stages in wound healing are clotting, the proliferative stage, angiogenesis, fibroplasia, epithelialization, and remodelling phase. Tanvir *et al.* [7] argued that the leaf extract of the *Spermacoce verticillata* helps in the proliferative stage of wound healing which overall accelerates the wound healing process. Studies have shown that 70% of wound healing medicines are made from the metabolites of plants [8]. The Rubiaceae family has more medicinal valuable plants available than any other plant family. *Spermacoce verticillata* is one of the important species that has a role in wound healing. For successful wound healing, the stages of wound healing should be carried out properly. Some factors can disrupt the sequence of wound healing such as local factors containing blood sugar that seriously affect the wound healing and external factors such as contamination of microbes in the wound.

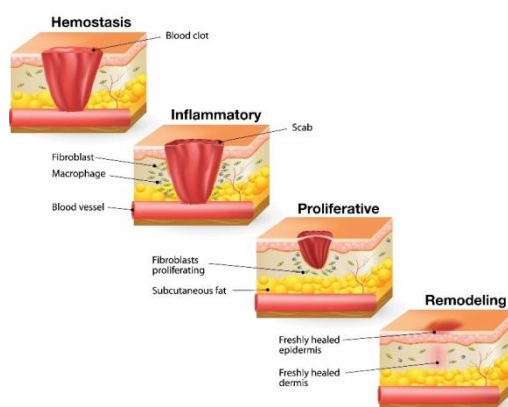


Fig. 2. Steps of wound healing by *Spermacoce verticillata* (Source: Self-created)

The leaf is one of the important organs in plants, here most of the chemical reaction take place such as photosynthesis, glycolysis, Krebs cycle, and hence a lot of metabolites are produced. These metabolites have various properties. Singh *et al.* [9] stated that the wound healing property of leaf extract helps the body's immune system to fight the microbes that cause a delay in the wound healing process by releasing harmful metabolites. Metabolites found in *Spermacoce verticillata* have a multidirectional activity to stimulate the wound healing activity such as accelerating the fibrin production with the help of blood cells. The leaf extract can be dissolved in methanol, chloroform, and water for their optimal use. Fibrin is a type of polymer made out of protein that blocks the exit point of blood and fluid. The other property is the reduction of toxins produced by the microbes that delay fibrin production.

## 2. MATERIALS AND METHODS

The research philosophy can be defined as a collection and analysis of data, and their description [8]. This literature is based on the *secondary qualitative research method* as there is the use of a journal, science articles to collect the data about the metabolites that are found in *Spermacoce verticillata*. Analysis of the result found that 70% of the antimicrobial and wound healing drugs come from plant-based metabolites [10]. These metabolites can act as antimicrobial agents and as wound healing agents.

This literature is also based on the *deductive approach* that describes the scientific investigation about the topic and collection of data from appropriate scientific journals. The steps including wound healing by the usage of leaf extract obtained indicate that it is based on a deductive approach [10]. This is scientific literature hence it is based on the correct facts that have been collected to justify the literature therefore it can be defined as a *positivism* research approach. The research article is based on the *descriptive approach* that is by this research the question 'what diseases can be cured by the leaf extract' and 'why plant-based metabolites are effective against most of the microbes' can be answered.

## 3. DISCUSSION

### 3.1 Usage of Leaf Extract of *Spermacoce verticillata* for Curing Diseases

Microbes are everywhere, the disease caused by the microbes are of various types. There are different kinds of microbes present in the human body, by the exposed wound or sensitive skin the metabolites produced by them can harm the human body severely. Aamir *et al.* [10] stated that the disease can be formed by certain types of microbes such as fungus, protozoa, bacteria, and they cause superficial infection such as skin disease. The leaf extract of *Spermacoce verticillata* works upon the external infection caused by the microbes such as athlete's foot, ringworm, cellulitis, erysipelas, and ailments alike.

**Table 1. Compounds found in Rubiaceae family (After: [11])**

Classification	Compound	Biological activities
Alkaloid	Cytochalasin D	Antifungal
Alkaloid	11-bromo roquefortine	Antibacterial
Coumarin	4-hydroxy-mellein	Antifungal
Coumarin	8-methyl-mellein	Antifungal
Meroterpene	guignardone I	Antibacterial
Meroterpene	guignardone B	Antibacterial
Polyketide	mycoleptones A	Antiprotozoal
Polyketide	mycoleptones B	Antiprotozoal

**Table 2. Table showing plant parts used to extract metabolites that have medicinal value (Rubiaceae family)**

Plant part used	Number of species
Leaf	17
Bark	6
Root	5
Fruit	3
Seed	2
Whole plant	1
Aerial part	1
Stem bark	1

Suksungworn *et al.* [11] argued that *Spermacoce verticillata* has various compounds that act as antifungal, antibacterial, and antiprotozoal agents. Some of the compounds discerned by Sukungsworn are **cytochalasin D**, **11-bromo roquefortine**, **4-hydroxy-mellein**, **8-methyl-mellein**, **guignardone I**, **guignardone B**, **mycoleptones A**, and **mycoleptones B**. These compounds are classified as **alkaloids**, **coumarin**, **meroterpene**, and **polyketide**. (see list in Table 1 below) These compounds are found in the leaf extract of almost every species of the Rubiaceae family and act as antimicrobial properties that also have wound healing properties which reduce the microbial load in the wound. Leaf extract of *Spermacoce verticillata* has been used by the tribal people for many years. Currently, western countries are investing in this species to collect the base compound for their medicine.

### 3.2 Analysis of Properties of Leaf Extracts Acting as an Antimicrobial and Wound Healing Agent

The Rubiaceae family has one of the most medicinal valued plants available. *Spermacoce verticillata* has excellent antimicrobial activity and wound healing properties that are mainly found in the leaves. Ajaib *et al.* [12] showed that the extraction of leaves can be done using various solvents such as alcohol, methanol, chloroform, or water. The activity of the compounds is dependent on the solvent used, hence choosing the correct solvent for each compound is important. Methanol as a solvent works well, many bacteria such as *Bacillus subtilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, show less activity in the presence of methanol-extracts. The basic principle is the same: the leaf extract has various compounds that have several activities regarding

antibacterial, antiprotozoal, antifungal. These compounds have several properties that help to decrease the population of the microbes, for example by inhibiting cell wall formation, by inhibiting the protein synthesis, by degeneration of the genetic material, by depolarizing the cell membrane, and many more.

Inhibition of the cell wall formation leads to the destruction of the protoplasm of the particular microorganism, inhibiting protein synthesis can lead to cease of metabolite production of the microbes, degeneration of the genetic material results in death of the particular microorganism. The cell membrane is a polarized structure that repels the charged particles to enter or exit the cell of the microorganism; depolarizing leads to the destruction of the cell membrane and hence to the death of the microbe. Patel *et al.* [13] stated that the wound healing property is directly related to the antimicrobial properties of the leaf extract. The wound can be defined as damaged skin tissue, without proper treatment this damaged tissue can lead to infection and increase the microbial activities at the wound. The leaf extract promotes fibrin protection that acts as a barrier between blood and the outer surface of the skin, also it acts on microbes that are present on the wound borders and can cause infection.

### 3.3 Importance of Rubiaceae Family in Medicinal Value

The Rubiaceae family is one of the largest tropical families that are found all over the world. Several plant species are found in the Rubiaceae family such as *Coffea arabica*, *Cinchona officinalis*, *Hamelia patens*, *Rubia sp.*, *Gardenia sp.*, and *Ixora sp.* These plants can be used in various diseases such as ulcers, jaundice, asthma, leprosy, cough, fever, hyperacidity, and

so on. Authinarayanan et al. [14-16] argued that these plants have several metabolic compounds that have a beneficial impact on those diseases, some of the compounds are decahedron-2-methoxy,  $\beta$  sitosterol-glucoside, and isovanillin. The compounds are derived from the various parts of the plants such as a leaf, bark, root, fruit, seed, or the whole plant.

#### 4. CONCLUSION

The use of plant-based medicine has been occurring since ancient times. The medicinal value of the plant is extraordinary; it is also used by many medical organizations and tribal people that live in tropical areas on earth. The invention of modern chemicals that have a quick response in any kind of disease, also have the side effects, whereas plant-based drugs have very few or no side effects. *Spermacoce verticillata* L is one of the medicinally valued plants of the family Rubiaceae. The leaf extract of this species has various medicinal values regarding antimicrobial activities and wound healing. More use of these kinds of shrubs can comprehensively reduce the chance of side effects that can cause other problems.

#### CONSENT

It is not applicable.

#### ETHICAL APPROVAL

It is not applicable.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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