

A REVIEW ON PHYTOPHARMACOLOGICAL ASPECTS AND ANTIMICROBIAL ACTIVITY OF CHLOROPHYTUM BORIVILIANUM AGAINST BACTERIAL PATHOGEN

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ABSTRACT

Safed Musli known as *Chlorophytum borivilianum* is an herb which is rarely found in India but normally found in forest area but now these days its use in Ayurveda is increasing day by day, so currently it is being cultivated at large scale.

In present study we used two species of *Chlorophytum* viz., *Chlorophytum kolhapurens* and *Chlorophytum baruchii* for its potential antibacterial activity. Crude methanol extracts as well as active compound methanol extract of *Chlorophytum* species were screened for *In vitro* antimicrobial activity and also to evaluate the phytochemicals present in the species. Disc diffusion method was used to study the antimicrobial activity against bacteria *Staphylococcus aureus*, *Escherichia coli*, *Enterococcus fecalis*, *Pseudomonas aeruginosa* and *Proteus vulgaris*.

The study was conducted to examine the antimicrobial activity of methanolic crude extract from different parts of the *Chlorophytum borivilianum* plant against pathogenic microorganisms and to assess antimicrobial activity by MIC and structural characterization of purified saponin of *Chlorophytum borivilianum* by using spectrophotometric and NMR analysis.

I. INTRODUCTION

Safed musli (*Chlorophytum borivilianum*) is a herb, belongs to family *Liliaceae*. It was originally grown in thick forests of India. About 300 species are distributed throughout the tropical and subtropical parts of the world. Tropical and subtropical zones of Africa are the probable centres of origin of the genus. Seventeen species of *Chlorophytum* had been reported in India. In India, it is considered as a valuable medicinal herb, whereas in other parts of the world it is being used as ornamental plant. The roots (tubers) are rich in alkaloids, vitamins, minerals, proteins, carbohydrates, saponins, polysaccharides and steroids.[1]

The prevailing environmental conditions such as high temperature, humidity, etc., promote not only the growth of microorganisms but also disturb the symbiotic relationship between host-microbes homeostasis and this leads to an increase in various diseases such as urinary tract infection (UTI), influenza, endocarditis, meningitis, tuberculosis, etc

Chlorophytum borivilianum contains proteins (8-9 %), carbohydrates (41 %), root fibres (4 %), saponins (2-17 %). Saponin is the chief medicinal compound present in the roots. Saponins and alkaloids present in the plant are the primary source of its significant medicinal properties.[2]

Saponins of stigmasterol and sarsasapogrnin with sugars as xylose, arabinose and glucose were extracted from the methanolic fraction of the leaves .[3] In continuation of our interest in this family the preliminary phytochemical, antibacterial and antifungal properties of *C. borivilianum* are presented.

Due to the climatic change and poor human lifestyle, human beings are more prone to infections and diseases. According to the World Health Organization (WHO) study, more than 80% of the world's population depends on prescription medicines and this is a significant issue of the society with regard to health care.

Normally, *C. borivilianum* is used to treat erectile dysfunction, impotence in men, oligozoospermia, antioxidant properties of sperm. Reports have shown that the root extracts of *C. borivilianum* possess anti-pathogenic activities and other medicinal properties. Because of its high medicinal value, the root of the plant has been exploited and reported to be an endangered species. The leaves and stem extracts of *C. borivilianum* also serve as a strong antimicrobial agent against Gram-positive and Gram-negative bacteria.[4]

1.1 Vernacular Name

Sanskrit : Swetha musli.

Hindi : Safed musli, Hazarmuli, Satmuli

Gujrati : Ujlimusli, Dholi musali

Malyalam: Shedeveli, Shedheveli.

Marathi : Safed musli, Sufed Musli, Kuli.

Tamil : Tannirvittang, Tannirvittan-

Kizhangu, Vipurutti,

Taniravi thang

Telgu : Tsallogadda, Swetha musli.

Arabic : Shaqaqule-hindi

Sinhalese : Hirtha-wariya,

U.P : Khairuwa

Arabic : Shaqaqule.

English : India spider plant, Spider plant

(India), White musale.

French : Chlorophytum medicinal

1.2 Ayurvedic Description

Botanical name: *Chlorophytum borivilianum*

Sanskrit name : Swetha musli

Synonyms : Safed musli

Properties :

Rasa : Sweet, Bitter

Guna : Moist, Unct

1.3 Traditional Use

Traditionally, tubers are used in the treatment of rheumatism and the leaves as vegetable in various culinary preparations. It is traditionally used for its aphrodisiac properties in lack of libido male impotency, oligospermia. It is also widely used as a general health promotive tonic and for delaying the ageing process. Dried root powder increases the lactation amongst the feeding mothers and lactating cows. It also removes the knee pains within a week if taken daily with milk[5,6]. Leaves are eaten by the tribal people of Western Ghats as an expectorant.

In the traditional diet of nursing mothers (after confinement) its powder is added in the preparation of laddoos (sweet prepared in ball form) to be taken as an energizing food.

Chlorophytum borivilianum (safed musli) popularly known as the Indian Ginseng which is traditionally used as a health promotive tonic, an adaptogenic drug, antioxidant, anti-arthritis, anti-inflammatory, antipyretic, galactagogue, hyper-cholesterolemia, hepatoprotective, hypolipidemic, anthelmintic, antiulcer, antistress, antiviral, antifungal, anti-tumour, anti-mutagenic, antidiabetic, antimicrobial, larvicidal activity, anticancer, anti-ageing process, aphrodisiac, and total rejuvenator.[7]

There are 8 common safed musali found in different parts of India such as 1) *Chlorophytum borivilianum*, 2) *Chlorophytum arundinaceum* 3) *Chlorophytum tuberosum* 4) *Chlorophytum malabericum* 5) *Chlorophytum attenuatum* 6) *Chlorophytum breviscapum* 7) *Chlorophytum filicinum* 8) *Chlorophytum gonocladum*.

A combination of *safed musli* leaves with other herbs makes the human body resistant against the attack of sex related diseases and also delays the menopause. No researcher has yet reported on anti-inflammatory activity of root tubers of this plant. Therefore, it is worth conducting an investigation on the anti-inflammatory activity of methanolic extract of *C. borivilianum* root tubers.[8]

1.4 Cultivation

C. borivilianum is found in various countries but mostly in the forest area. In India, it is cultivated in various parts but found abundantly in Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Karnataka, and Haryana). It is found in areas with high altitude and grown in about 400 hectares of land for root tubers and in tropical and sub tropical climates. In India, the jungles the climatic conditions are suitable so it grows naturally.[9]

If the climatic conditions are suitable for its growth such as range of temperature and rainfall conditions, this plant can grow well .

The ideal requirements for its production is a sandy loamy soil with suitable drainage, on the other hand for the growth of good tuber, The ph required for its growth is in the range of 6 to 7, farm yard with decomposed manure and drainage ditches.

The planting density is about 80,000 fingers per hectare, weighing approximately 400-500 kg. Leaves turn yellow and fall off after 3.0 to 3.5 months, but they are left in the field for some more time and moisture content is maintained for ripening which increases their medicinal properties.

1.5 Plant Description

borivilianum (Family: Asparagaceae; sub family: Anthericoideae) has 6-16, radical, 13-23 cm x 1-2.5 cm in size, spirally imbricate at the base, sessile, linear ovate leaves; green-yellow coloured, bear 3-12 seeds in each fruit and small, black, angular in shape, endospermic seeds.

1.5.1 Morphology

C. borivilianum is a herb which is tiny and it grows once in year with altitudes up to 1500m.

Usually it grows in tropical and sub-tropical climates. The maximum range of height is 1.5ft and depth is of 10 inches.[10]

Root

Roots pale brown to white colour with characteristic odour and are tasteless in nature. Root tubers are fleshy, fascicled and directly originate from the stem disc devoid of any fibrous structure and distinguished it from other species of *Chlorophytum* genus. The shape of tubers were cylindrical, the thickness.

The thickness and length on the average is 0.9 cm and 8 cm and the shape were cylindrical.[11]

Leaves

C. borivilianum is a herb with lanceolate leaf. There are radical leaves in number 6-13, the leaves at the base are spirally imbricate, sessile in nature, with acute apex and less than 30cm long. There is horizontally spreading of leaves of safed musli, having smooth surface, margins are wavy with parallel venation.

Flowers and fruit

Flowers of *C. borivilianum* are small, white, bracteate, pedicillate, zygomorphic usually arranged in alternate clusters, each cluster comprising of 3 flowers. The flower clusters are dense on the upper part of the scape; bracts are linear, papery and purplish, 1.0 - 10.5cms long; pedicle whitish and 6 -10 mm long. It bears green to yellow coloured fruit which is almost equal in length and breadth. The seed is very small, black and enclosed in the holes. In one hole, there are about 10- 12 seeds. Seeds are endospermic, onion like, black coloured and angular in shape.[1]

1.5.2 Microscopy

Fresh tuberos of entire *C. borivilianum* shows various microscopic characters. Without cuticle epidermis is present and many unicellular root hairs are present in stomata. Cortex possesses parenchymatous cells with intercellular spaces. Starch is not present. Below the cortex barrel shaped closely arranged parenchymatous cell lies which are shown in Endodermis (50µm thick) and forms a ring.

Pericyclic cells are single layered and are present below the endodermis which are uniseriate and made up of thin walled parenchymatous cells.

Xylems composed of a single layered round metaxylem towards the pith, protoxylem towards the periphery. Phloem composed of companion cells and phloem parenchyma. [12,13]

II. LITERATURE REVIEW

Deore and Khadabadi, (2010) The roots of *Chlorophytum borivilianum* contain three important fatty acids, common sterol, stigmasterol and one furostanol saponins.

Dhanalekshmi et al., (2010) The aim of this study is to explore the wound healing and antimicrobial effects of crude ethanolic extract of the whole plant of *Evolvulus alsinoides* L., (Convolvulaceae).

Ekins et al., (2007) The in silico pharmacology paradigm is ongoing and presents a rich array of opportunities that will assist in expediting the discovery of new targets, and ultimately lead to compounds with predicted biological activity for these novel targets.

Goud et al., (2008) Antibacterial activity and phytochemical tests of eight whole plant methanol extracts belonging to family Euphorbiaceae were evaluated.

Kandalkar et al., (2009) *Euphorbia hirta* Linn. (Euphorbiaceae), a pantropic herbaceous wild plant which has been widely used in several countries as an antidiarrhoeal, antidiuretic, also as a treatment of expectorant and also remedy for bronchitis, asthma, intestinal ailments of children and for various skin diseases.

Kandalkar et al., (2010) Extract from the leaves of *Euphorbia hirta* Linn. was investigated for antioxidant activity. *Euphorbia hirta* Linn. showed invitro and in-vivo powerful antioxidant activity may be responsible for its wide and popular traditional use.

Kapetanovic et al., (2008) It is generally recognized that drug discovery and development are very time and resources consuming processes. There is an ever growing effort to apply computational power to the combined chemical and biological space in order to streamline drug discovery, design, development and optimization. It is expected that the power of CADD will grow as the technology continues to evolve.

Kumar et al., (2010) Thus, our study shows that oral administration of *E. hirta* flower extracts in alloxan diabetic mice showed antidiabetic effects. The extracts also exhibit in vitro antioxidative effect. Further phytochemical and pharmacological investigations are needed to isolate and identify the active constituents responsible for the activity.

Ogueke et al., (2007) Leaves of *Euphorbia hirta* used in traditional medicine for the treatment of boils, wounds and control of diarrhoea and dysentery was extracted by maceration in ethanol.

Okimoto et al., (2009) The application of molecular dynamics simulations to virtual screening for lead discovery is both effective and practical. However, further optimization of the computational protocols is required for screening various target proteins.

Patil et al., (2009) *Euphorbia hirta* has been reported as increase in urine output, antidiarrheal, antispasmodic, anti-inflammatory etc.

Pitchai et al., (2010) Drug discovery from plants involves a multidisciplinary approach combining ethnobotanical, phytochemical and biological techniques to provide us new chemical compounds (lead molecules) for the development of drugs against various pharmacological targets, including cancer, diabetes and its secondary complications.

Ramesh et al., (2010) The present study revealed the immunomodulating potential of an Indian medicinal plant *Euphorbia hirta*. This plant's immunomodulatory potential has not been reported thus far to our knowledge. However, antibacterial activity of this plant has been reported.

Sethiya et al., (2010) Shankhpushpi is a well-known and extensively used plant in Ayurveda with therapeutic potential as memory enhancer. There is still need to evaluate each plant for their comparative chemical markers based identification and their comparative biological potency.

III. PHARMACOLOGICAL ACTIVITY OF *C. BORIVILIANUM*

3.1. Healing power and curative properties

Impotency

The dried roots of asparagus was found to be effective as aphrodisiac in Ayurveda. It has been reported that on regular use of *C. borivilianum* it is found to be effective in premature ejaculation and impotency.[14]

3.2. Anti-helminthic activity

For centuries, parasites have been of great concern to the medical field and the helminthes still cause considerable problems for human beings and animals. Now days, reoccurrence is one of the leading issue and most of the pharmaceutical dosage form available in the market are not effective.[1,15]

3.3. Aphrodisiac activity

All the extracts of *C. borivilianum* show significant results but the aqueous extract derived from the *C. borivilianum* roots is found to be effective spermatogenic agent and aphrodisiac activity.

3.4. Anti-oxidant activity -

Almost all the *C. borivilianum* extract was found to be very effective against free radicals. A study has shown antioxidant activity by using an assay named as free radical scavenging and lipid per oxidation assay.[15,16] The aqueous extract of *C. borivilianum* (250 mg/kg for 7 days) inhibits significantly the levels of DPPH free radicals and thiobarbituric acid reactive substances, respectively in a dose-dependent manner.[17]

3.5. Anti-stress activity;-

It was reported that from *C. borivilianum*, different extracts were isolated and different extracts show different activities. Recently, a study has shown anti-stress activity in rat model using chronic cold restraint. was selected to evaluate antiulcer activity. The effect of single oral dose of the alcoholic extracts at the dose of 200 mg/ kg reduces the ulcer index significantly ($p < 0.001$) compared to that of control group.[18]

3.6. Anti-tumour and anti-mutagenic activity-

Extracts of *C. borivilianum* has shown effective in Cancer and mutagenic activities. But the roots were found to be effective in cancer patients.

3.7. Anti-diabetic activity-

A fructo-oligosaccharide extract was found to be effective in diabetics. A study has revealed that this extract after isolation from *C. borivilianum* was found to be effective and is potent anti-diabetic.[15]

3.8. Antimicrobial activity-

Different extracts of *C. borivilianum* was found to be efficacious against various pathogens. A study has revealed *C. borivilianum* was screened for antimicrobial potential. It was tested using micro broth dilution assay, against 8 types of bacteria and pathogenic fungi.

Water extracts of *Chlorophytum borivilianum* showed antimicrobial activity in a range of 75-1200 µg/ml[19]

3.9. Larvicidal activity

Safed musli has been found to be effective against larvicides such as poisonous agents, poisons which affect stomach, growth regulators or biological control agents. But the saponin extract (especially methanolic, crude saponin, and purified saponin extract) is effective against various species of mosquitoes such as *Anopheles stephensi*, and *Aedes aegypti* on the basis of Lethal dose 50 and effective dose 50. A study revealed that every extract of *C. borivilianum* was found to be effective against larvicides but the saponin extract was found to be more effective.[20]

3.10. Immunomodulatory activity of *Chlorophytum borivilianum*

Chlorophytum borivilianum (Santapau & Fernandes) (Liliaceae) is a very popular herb in traditional Indian medicine and constitute a group of herbs used as Rasayan. or adaptogen. Ethanolic extract of the roots and its saponin were evaluated for their immunomodulatory activity. Effect of azathioprine-induced myelosuppression and administration of extracts on hematological and serological parameters was determined. Administration of extracts greatly improved survival against *Candida albicans* infection.

An increase in delayed-type hypersensitivity response (DTH), % neutrophil adhesion and *in vivo* phagocytosis by carbon clearance method was observed after treatment with extracts .

Immunostimulant activity of ethanolic extract was more pronounced as compared to sapogenins. The results, thus justifies the traditional use of *C. borivilianum* as a rasayana drug. Scientific literature is continuously reporting plant drugs having immunomodulatory activity, The Indian system of medicine .Ayurveda., conceptualizes a category of drug activity known as Rasayana.. The word Rasayana is composed of two words .Rasa. meaning elixir and .Ayana. meaning house. The word therefore signifies property of the plant that helps to rejuvenate the system, i.e. adaptogenic activity ..Rasayan. therapy prevents diseases and counteracts the aging process by means of optimization or homeostasis.[21]



Whole plant of *C.borivilianum* (Img1.1)



Roots Of *C. Borivilianum* (Img 1.2)



Flower of *Chlorophytum Borivilianum*(Img 1.3)

IV. STUDY OF MATERIAL AND METHODS

4.1. Collection of plant sample

The plant was obtained from medicinal garden of Invertis University, Bareilly, Uttar Pradesh, India.

Chlorophytum borivilianum plant material was obtained from Nandan Biomatrix Ltd. and maintained in vitro by micropropagation techniques. These plantlets were used for genetic transformations.[22]

4.2. Plant Preparation And Extraction

The plantlets of *C.Borivilianum* were washed thoroughly under running tap water, dried on paper towel, then kept in oven at 60°C for proper drying and finally powdered. The dried powder of the plant (20gm) was dissolved in 100ml of different solvent water, glacial acetic acid, acetone (from higher polarity to lower polarity) and kept for 72 hours.

The extract was collected and filtered. This procedure is repeated for three times for proper extraction. The extract collected was pooled, evaporated to dryness by rotary evaporator. Then the residues were resuspended in DMSO stock concentration of 100ml-1.[21]

4.3. Microorganisms Tested

The bacterial and fungal strains used in the study included *Bacillus subtilis* (Bs), *Staphylococcus aureus* (Sa) (MTCC 902), *Escherichia coli* (Ec) (MTCC 1687), *Pseudomonas aeruginosa* were obtained from national collection of industrial microorganisms, national chemical laboratory, Pune in December 2009 and were maintained on nutrient agar. All the four bacterial pathogens are responsible for nosocomial disease.[23]

4.4. Antimicrobial Activity Test

This test is based on the agar well diffusion method.

We have used the agar cup diffusion method to test the fractions for antimicrobial activity. From stored slopes, 5 ml single strength nutrient broth was inoculated. The tubes were well shaken and incubated at 37°C for 18-24 hours.

Diameters of zones of inhibition were determined as an indication of activity after incubating the plates at 37°C for 24 hours for bacteria and. When seeded with bacteria, each plate had wells filled with DMSO. Ampicillin was used as a reference drug for antibacterial studies. Antimicrobial activity in the form of the zone of inhibition (ZOI) was measured in millimeters (mm).[24]

V. PHYTOCHEMICAL TEST

Sr.no	Name of method	Detected	Reference
1	Cup diffusion method	Diameters of zones of inhibition were determined Eg. gram +ve & gram -ve Bacillus subtilis, E.coli	Citation[(IJASE) 2 Dec 2014, 83-89]
2	Blotter method & potato dextrose agar medium	Incidence of fungi on root tube of c.borivilianum Eg. A.niger, F.oxysporem	Citation NCRDAMDS-2018,167-170]
3	Mic test -broth micro dilution process	Identifies The minium conc. Of ,at which it shows the inhibition of microbial growth. Eg. M. tuberculosis	Citation Arab j. chem 2017
4	Pot trial method	The saponin was quantified by a colorimetric reaction .(VAM fungi)	Citation Tenant 1995

Plant extract were screened for the charecterisation of phyto-compounds such as alkaloids, glycosides, saponin glycosides, steroids and tannins.

[a] Carbohydrates: 1 ml of 1mg/ml concentration of the extract was taken and 1ml of each Fehling’s A and B were added to it. The mixture was boiled, and if red precipitate was formed, the result confirmed the presence of carbohydrate in the extract.

[b] Phenols and tannins: 1mg/ml concentration of 1 ml extract was taken and 5ml of 2% FeCl3 was added to it. Blue or green-black coloration indicated a positive result.

[c] Saponins: 1 ml extract of 1 mg/ml concentration was taken and 3ml of distilled water was added to it. Then it was shaken vigorously. The development of froth indicated the presence of saponin.

[d] Flavonoids: 1ml of 1mg/ml extract has been taken and 2ml of 2% NaOH has been added. With the addition of 2 ml HCl, the yellow colour turned into colorless and this indicated a positive result.

[e] Catecholic tannin: 1ml plant extract (1mg/ml) was added to 2ml distilled water and then a few drops of ferric chloride were added to it. The appearance of green-black colour confirmed the presence. [f] Alkaloids: 2ml of 1% picric acid was added to 1 ml plant extracts (1mg/ml). Yellow precipitate showed positive results.

[g] Terpenoids: 2ml chloroform was added to the 1mg/ml concentration of plant extract. Then, 2ml of concentrated H2SO4 was added slowly to it. A reddish- brown coloured interface was observed, indicating the presence of terpenoids. [h] Steroids: 1ml of plant extract (1mg/ml) was added to 2ml of chloroform and mixed properly. After that, 2ml of concentrated H2SO4 was added to it. The appearance of red colour in the chloroform layer indicated a positive result.

[i] Starch: 1ml of plant extract (1mg/1ml) was added to 2 ml of iodine solution and the development of blueblack colour indicated a positive result.[25]

VI. RESULT

Table 1.1 Phytochemical Analysis of Methanolic Extract of Fresh Roots, Stem And Leaves of *C.Borivilianum*

SR.NO	PHYTOCHEMICALS	STEM EXTRACT	LEAF EXTRACT	ROOT EXTRACT
1	Alkaloids	++	+	+
2	Flavonoids	+	++	+++
3	Terpenoids	-	-	-
4	Starch	+	-	-
5	Steroids	+++	+	++
6	Carbohydrate	++	+	+
7	Saponins	+++	+++	++
8	Phenol And Tannins	+++	++	+
9	Catecholictanin	+	+	+
10	Gallic Tannin	-	-	-

From the Table 1 it has been calculated that the leaves and stem of *C. borivilianum* contain the presence of alkaloids, glycosides, saponin glycosides, steroids and tannins. For the antimicrobial activity the diameters of the inhibition zones were measured and recorded in the Table 2, 3, 4, 5, and 6. The comparative study for diameter of inhibition zone for all four bacteria in different extract have been measured and recorded in Figure 1

- Phytochemical Test

To check the presence and absence of phyto-compounds in *C. borivilianum*, the phytochemical analysis was performed. Results of the phytochemical analysis of the root stem and leaf extracts are summarized in (Table 1.1). On analyzing the results, it has been confirmed that all three parts of the *C. borivilianum* contained 10 phytochemical compounds, as indicated in (Table 1.1). Among them, alkaloid, flavonoid, steroid, saponins and phenols were found to be present predominantly in the plant. The higher concentrations of carbohydrates, steroids, alkaloids and starch were present in the stem of the plant, whereas flavonoids, phenols and tannins, were present at higher concentrations in the extract of the roots, and saponins were present at a higher concentration in the leaf extract of the plant.

Table 1.2. Antimicrobial Activity of Leaf extracts *C borivilianum*[24]

	Extract Conc. Mg/ ml	Staphylococcus aureus	Escherichia coli	Klebsiella	S. subtilis
<i>C.borivilianum</i> Leaf	250	+	-	-	+
	500	++	-	+	-
	1000	+++	++	++	+++
(-) : No Inhibition (< 10 mm), (+) : Low activity (10- 13 mm), (++) : relative high activity (14-20 mm), (+++) : High Activity (> 20 mm), Not Done (ND)					

Table 1.3: Antimicrobial Activity of Stem extracts *C borivilianum*[24]

	Extract Conc. Mg/ml	Staphylococcus aureus	Escherichia coli	Klebsiella	S. subtilis
<i>C.borivilianum</i> Stem	250	+	-	-	+
	500	++	-	+	-
	1000	+++	++	++	+++
(-) : No Inhibition (< 10 mm), (+) : Low activity (10- 13 mm), (++) : relative high activity (14-20 mm), (+++) : High Activity (> 20 mm), Not Done (ND)					

Table 1.4: Antimicrobial Activity of extracts (Petroleum Ether)[24]

<i>C. borivilianum</i> Petroleum Ether	Extract Conc. Mg/ml	Staphylococcus aureus	Escherichia coli	Klebsiella pneumoniae	S .sabtilis
	250	-	-	-	ND
	500	-	-	-	ND
	1000	-	-	+	ND
(-) : No Inhibition (< 10 mm), (+) : Low activity (10- 13 mm), (++) : relative high activity (14-20 mm), (+++) : High Activity (> 20 mm), Not Done (ND)					

Table 1.5. Antimicrobial Activity of extracts (Methanol)[24]

<i>C.borivilianum</i> Methanol	Extract Conc. Mg/ ml	Staphylococcus aureus	Escherichia coli	Klebsiella pneumoniae	S .sabtilis
	250	-	-	-	ND
	500	+	-	-	ND
	1000	++	-	+	ND
(-) : No Inhibition (< 10 mm), (+) : Low activity (10- 13 mm), (++) : relative high activity (14-20 mm), (+++) : High Activity (> 20 mm), Not Done (ND)					

Table 1.6. Antimicrobial Activity in Ampicillin[24]

Control Ampicillin 1mg/ml	Staphylococcus Aureus	Escherichia coli	Klebsiella Pneumonia	S. sabtilis
	+++	++	+++	+++
	(-) : No Inhibition (< 10 mm), (+) : Low activity (10- 13 mm), (++) : relative high activity (14-20 mm), (+++) : High Activity (> 20 mm), Not Done (ND)			

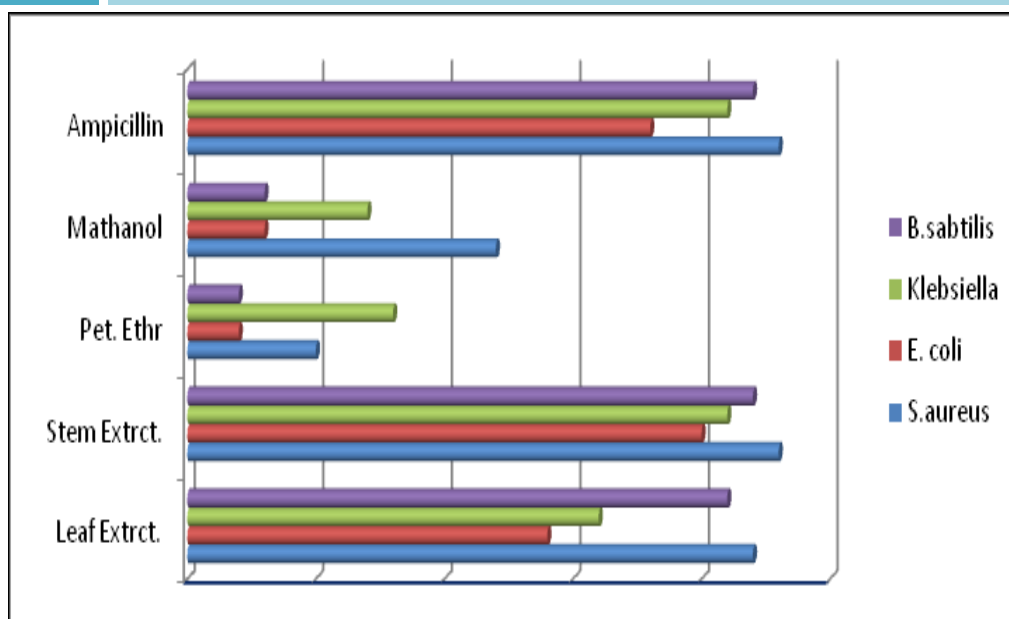


Figure 1. Comparative antimicrobial activity against different extracts of C. borivilianum in 1000 mg/ml

VII. DISCUSSION

The above result in the table 1 to 6 and in the chart -1 showed that *C. borivilianum* have very potent antibacterial agent can be used as a potent antimicrobial agent for the treatment of diseases. Thus further work can be carried out on the isolation procedure for finding out the exact active moiety responsible for the biological activity

The extract of leaves and stem was tested against the two Gram positive and two Gram negative bacteria.

Finally it can be concluded that the leaves and stem extract of *Chlorophytum borivilianum* can be used effectively against certain bacteria causing disease in human beings as it is a potent antimicrobial agent.

The medicinal properties of the roots of *C. Borivilianum* are known for a long time for various therapeutic applications in human society.

In the present investigation strongly demonstrated that the *C. borivilianum* has potent antibacterial activity. The above result show that the leaf and stem extract of *C. borivilia* displayed concentration dependent antibacterial activities and this was comparable to that of the reference drug ampicillin at 1 mg/ml as shown in Table 6. Only the ethanol extract of the aerial parts of the plant inhibited the growth of bacteria at concentration of 1000 mg/ml and 500 mg/ml respectively. The petroleum extract of *C.borivilianum* was less sensitive to the bacteria at the test concentrations (Table 4).

The results of this study confirm the use of this plant as remedies for analgesic, anti-inflammatory and arthritic conditions. There is an absolute need for bioactivity guided fractionation and isolation of the active components in the plant extracts.

The methanol extract of *C. borivilianum* had not very impressive antibacterial properties (Table 5). This therefore becomes more relevant as the current antibiotics in use are of fast loosing effectiveness due to its emergence of resistant microorganisms.

The isolation of the components of the aerial parts of *C. borivilianum* methanol extract is in progress as very potent antimicrobial agent.

The results of our antimicrobial screening suggest that the bioactive compound of the *C. borivilianum* is more active towards the Gram-positive bacteria as compared to Gram-negative bacteria. Our findings are also confirmed with the reports of Sundaram *et al.* and Chakraborty and Aeri, where the antibacterial activity of the root extract of *C. borivilianum* with respect to Gram-positive bacteria has been described . The reason for a higher resistance in Gram-negative bacteria against the extracts is due to the hydrophobic nature of lipopolysaccharides present in the cell wall, which is impermeable to lipophilic compounds as compared to Gram-positive bacteria.

VIII. CONCLUSION

In India, Ayurvedic system of medicine has emerged out to be a precious gift of nature. *C. borivilianum* is known to be very popular herb in India and is widely used in traditional medicine use. Its ingredients are using in over a hundred formulations of Ayurveda and is very potent and effective herb. As it has tremendous properties and it is utilized for various conditions such as immunomodulator, anti-diabetic, anti-thelminic, larvicidal activity and so on. So, it has been found to be a true medicinal plant with excellent therapeutic effect.

The above result in the table 1 to 6 and in the chart -1 showed that *C. borivilianum* have very potent antibacterial agent can be used as a potent antimicrobial agent for the treatment of diseases. Thus further work can be carried out on the isolation procedure for finding out the exact active moiety responsible for the biological activity. The extract of leaves and stem was tested against the two Gram positive and two Gram negative bacteria. Finally it can be concluded that the leaves and stem extract of *Chlorophytum borivilianum* can be used effectively against certain bacteria causing disease in human beings as it is a potent antimicrobial agent.

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