

Pharmaco-Analytical and Invitro Evaluation of *NIRGUNDI (Vitex negundo Linn.)* W.S.R. to its Action on Bacteria Causing Respiratory Tract Infections

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Abstract- According to W.H.O respiratory infections stands first among the top ten causes of death in low-income countries. About 1.05 million people die annually which accounts for 11.3% of total mortality. Most of these infections are caused by organisms such as *Staphylococcus aureus*, *Klebsiella pneumonia*, *E.coli* etc. The herbs mentioned in Ayurvedic text have good potential as antimicrobial against local as well as systemic pathogens and they can be used in the treatment of infectious diseases. Unscientific and irrational use of antibiotics developed bacteria that show resistance to antibiotics. Soonly herbal medicines can fulfill these demands. The world health organization estimated that 80% of people worldwide rely on herbal medicine. Therefore there is an increasing need for the introduction of herbal remedies to overcome this problem. Single-drug therapy is preferred nowadays for easy availability, identification convenience in processing and economical too. Hence the present study has been conducted to evaluate and identify a cheap, safe, and cost-effective medicine for Kasa and Shwasa. In Ayurvedic classics *Nirgundi* has the properties like Katu, Tikta, Kashaya rasa, Ushna, Ruksha Gunas, Katu vipaka and Ushna Veerya. It is indicated in Kasa, Swasa, Prathisyaya, Krimi, Sopha etc. By considering these qualities of *Nirgundi*, a possible antibacterial action is inferred. Kaasaghna and Krimighna properties can be action on respiratory tract infections. This could be analyzed through invitro microbiological studies in the name of *Nirgundi* are identified botanically as, *Vitex negundo* Linn. Family- Verbinacea.

INTRODUCTION

Ayurveda is believed as upaveda of Atharvaveda. It is not just a system of medicine in the conventional sense of methodology for treating diseases, but it is a holistic science too. It believes in the theory that the fundamental unit of the universe, as well as the fundamental unit of the body is having

Panchabouthika constitution.

“सर्वं द्रव्यं पाञ्चभौतिकं अस्मिन्नर्थे।”⁽¹⁾

On the basis of this theory, it can be said that every material in the universe has some medicinal value. Acharya Charaka elucidates this theory by his prediction that,

अनेनोपदेशेनानौषधिभूतं जगति किञ्चिद्द्रव्यं उपलभ्यते।
तं तां युक्थिमर्थं च तमभिप्रेत्य।।”⁽²⁾

Every material in this Universe can be used as a medicine with the yukthi. The importance of medicinal plants has been recognized in the past. Among a number of plants described in Ayurveda, *Nirgundi* is one which holds greater medical importance. According to a report from the World Health Organization, more than 80% of the world's population depends on traditional medicine for their primary healthcare needs³. A popular local quote of the Bengalis in the Western Himalayan region of India translates as - A man cannot die of a disease in an area where *Vitex negundo* Linn, *Adhatodavasica* and *Acorus calamus* are found. The plant is referred in the Indian traditional circles as “*sarvaroganivarini*”⁴ (the remedy for many diseases). As *Nirgundi* is a well-known drug by common people and easily available hence this drug needs a literary review in which much research has been carried out on this plant. Regarding the etymology, synonyms, and morphological description, may explore further therapeutic quality for the benefit of public in a larger extent. In the present context, therapeutic utility is discussed, there are enormous descriptions found in all most all Samhitas and Nighantus. By observing the morphology, therapeutic utility, habit, and habitat different Acharyas have placed *Nirgundi* under different Vargas (group) for convenience of study.

Hence the present study has been conducted to evaluate and identify a cheap, safe, and cost-effective

medicine for Kasa and Shwasa. In Ayurvedic classics *Nirgundi* has the properties like Katu, Tikta, Kashaya rasa, Ushna, Ruksha Gunas, Katu vipaka and Ushna Veerya. It is indicated in Kasa, Swasa, Prathisyaya, Krimi, Sopha etc. By considering these qualities of *Nirgundi*, a possible antibacterial action is inferred. Kaasaghna and Krimighna properties can be action on respiratory tract infections.

MATERIALS AND METHODS

IN-VITRO STUDY

Evaluation of the antimicrobial action of *Vitex negundo* Linn. against *Staphylococcus aureus* and *Klebsiella pneumoniae* in vitro was carried out by Agar dilution method and Time kill assay.

METHODOLOGY

Antimicrobial study

Study of Antimicrobial Susceptability testing of the component was carried out in Department of microbiology K.V.G Medical College Hopital Sullia.

MATERIALS

PREPARATION OF SWARASA OF NIRGUNDI PATRA:¹³

The fresh leaves of Nirgundi is collected and washed thoroughly with water. It is crushed and by applying pressure the liquid (swarasa) is extracted.

MINIMUM INHIBITORY CONCENTRATION (MIC)

The Patra Swarasa of *Vitex negundo* Linn. were performed using Agar dilution method. One ml each of the undiluted (100%), 1 in 2 (50%), 1 in 4 (25%), 1 in 8 (12.5%) serial dilutions of the extract were added 19ml of sterile molten and Mueller Hinton agar cooled to 55°C, mixed well and poured into glass petri dishes of 90mm diameter. A growth control plate with standard drug Ciprofloxacin in infused with 5000ppm concentration was added to 19 ml sterile molten MuellerHintar Agar cooled to 55°C. The agar was allowed to solidify.

PREPARATION OF McFARLAND 0.5 STANDARD:

McFarland 0.5 standard was prepared by adding

99.5ml of 1% sulphuric acid and 0.5ml of 1.175% barium chloride. The solution was dispensed into glass tubes comparable to those used for inoculum preparation, tubes in thickness sealed tightly and stored in the dark at room temperature. McFarland 0.5 standard provides turbidity comparable to that of a bacterial suspension containing 1.5×10^8 colony forming units (CFU) per ml.

INOCULUM PREPARATION- Four to 5 colonies of pure culture of each of the test bacteria, *Staphylococcus aureus* ATCC25923, *Klebsiella pneumoniae* ATCC13882, and *E.coli* ATCC 25922 drawn from stock cultures of the Department of Microbiology, KVG Medical college and Hospital, Sullia, were inoculated to Mueller-Hinton broth incubated at 37°C for 3 to 4 hrs.

To standardize the inoculum, under adequate light, the inoculated broth and McFarland 0.5 standard or tubes were positioned side by side against a white card containing several horizontal black lines. The turbidities were compared by looking at black lines through the suspensions. The inoculum of the test bacteria matching with McFarland 0.5 Standard (1.5×10^8 CFU/ml) were further diluted with peptone water as to get a standard inoculum containing 10⁴ CFU/ml.

The standardized inoculum softest organisms were streaked on to each plate containing the diluted extract and on growth control plates. After overnight incubation at 37°C, the MIC was read as the lowest concentration of the extract that inhibited the visible growth of the test bacterium.

TIME KILL ASSAY (TKA)^{38,39}

The Patra swaras of plant *Vitex negundo* Linn. serially diluted in 1:2, 1:4

1:8 and 1:16 dilution and 1 ml of each added to peptone water containing 20mg/ml concentration. Each of the tubes containing the above dilutions of the extract was inoculated with test bacteria namely *Staphylococcus aureus* and *Klebsiella pneumoniae*. The inoculum volume of 0.02ml of the log phase of culture was adjusted to an initial bacterial concentration of 1.5×10^4 CFU/ml. All inoculated tubes were incubated at 37°C and observed for bactericidal activity after 2, 4, 6, 8 and 12 hours of incubation. A growth control of each test bacteria in peptone water without extract was included.

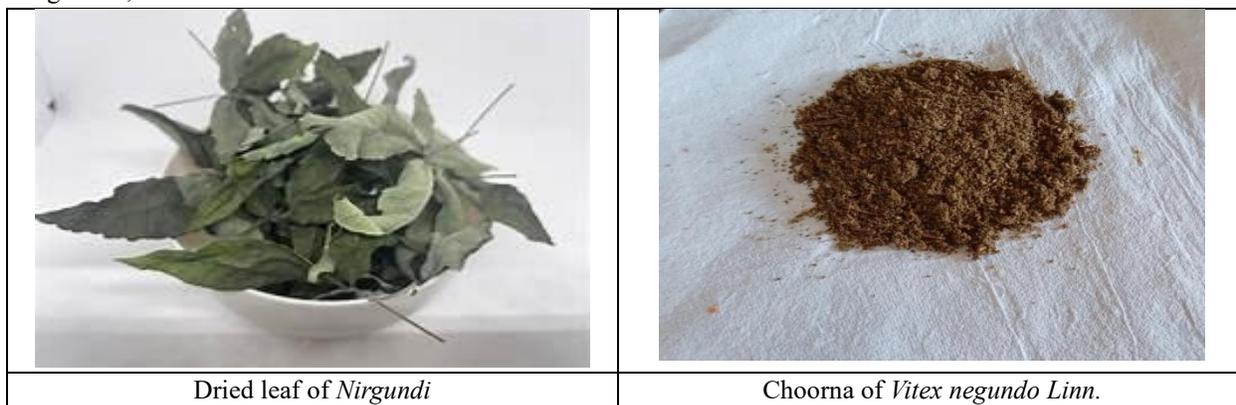
Subcultures of tubes showing no turbidity were done on MH agar plates, incubated at 37° c overnight and observed. The time taken by different concentrations of the extract to kill specific bacteria after a given time of incubation was recorded.

RESULT

Table:-1 Showing

PHARMACOGNOSTICAL STUDY: *Vitex negundo* Linn.

Image no:1,2

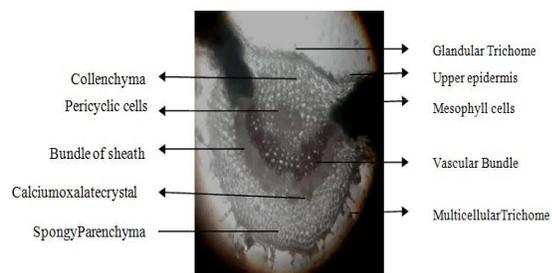


Dried leaf of *Nirgundi*

Choorna of *Vitex negundo* Linn.

MICROSCOPIC STUDY:

Image :3



Multicellular trichomes, oil globules, parenchyma cells, stone cells, prism shaped crystals and fragment of endosperm containing starch grains can be seen.

POWDER MICROSCOPY

Image: 4,5



OBSERVATION AND RESULT OF ANALYTICAL STUDY

Table No:-2 Showing

Physico-chemical parameters of leaves of *Vitex negundo* Linn. Parameter result(% ,w/w)

Foreign matter percentage	Nil
Total solids	1.22%
Brix value	6.00
Ash value	6.24%
pH (value of 10% solution)	5.16
Acid Insoluble ash	1.21%
Water soluble Extract	22.45%
Alcohol Soluble Extract	11.5%

QUALITATIVE TESTS

Extract of leaf of *Vitex negundo* Linn. churna was prepared with cold maceration technique. That was

further subjected for qualitative phytochemical screening.

The results are mentioned below:

Table No:- 3 Results of preliminary phytochemical tests on various extracts of *Vitex negundo* Linn.

Tests	Aqueous	Aocohol	Choloform	Acetone
1.Test for Carbohydrates				
a)Test for Reducing sugars				
Fehlings Test	+	+	+	+
Benedicts test	-	-	-	-
b)Non reducing Polysaccharides(starch)				
Iodine Test	-	-	-	-
2.Test for Proteins				
Biuret test	-	-	-	-
Xanthoprotein test	-	-	-	-
Million's test	-	-	-	-
3.Test for Aminoacids				
Ninhydrin test	-	-	-	-
4.Test for Fats and Oils				
Solubility test	-	+	+	+
Saponification test	-	+	+	+
5.Test for Steroids				
Salkowski reaction	-	-	-	-
Liebermann Burchard reaction	-	-	-	-
6.Test for Flavonoids				
Shinoda test	+	+	+	+
7.Test for Alkaloids				
Wagner's Test	-	+	+	+
Mayer's Test	-	+	-	+
Hager's Test	+	-	+	+
8.Test for Glycosides				
Keller- Killiani test	-	-	-	-
Modified Bortrager's test	-	-	-	-
9.Test for Tannins and Phenolic compounds				
5% FeCl ₃	+	+	-	+
Lead acetate	-	-	-	+
Acetic acid	-	-	-	+
Dilute Iodine	-	-	-	-
Dilute HNO ₃	+	+	+	+

Test for Inorganic components:

Prepared ash of the drug material was added with 50% of Nitric acid. The filtrate was subjected to analyze the inorganic elements.

Table No:-4 Showing Inorganic constituents

Inorganic components	<i>Vitex negundo</i> Linn.
Calcium	+
Magnesium	-
Phosphate	-
Sodium	-
Iron	+

Pottasium	+
Sulphate	+
Chloride	-
Carbonates	-
Nitrates	-

HPTLC ANALYSIS OF *NIRGUNDI* SWARASAM SAMPLE

A. SAMPLE DETAILS

Sample name – Nirgundi swarasam

B. TEST SOLUTION

10 g Nirgundi swarasam sample is taken, evaporated to dryness, extracted with 10ml Methanol and spotted as 10microlitre.

C. Stationary phase

Merk, 1.05554.0007, TLC Silica gel 60 F₂₅₄, 10x10 cm Aluminium sheet.

D. MOBILE PHASE

Toluene: Ethyl acetate: Formic acid: Methanol (7:5:1:0.5)

E. DEVELOPMENT

CAMAG 10 x 10 cm Twin trough chamber.

F. HPTLC INSTRUMENTATION

CAMAG Linomat 5, CAMAG TLC Scanner 3, CAMAG Reprostar 3.

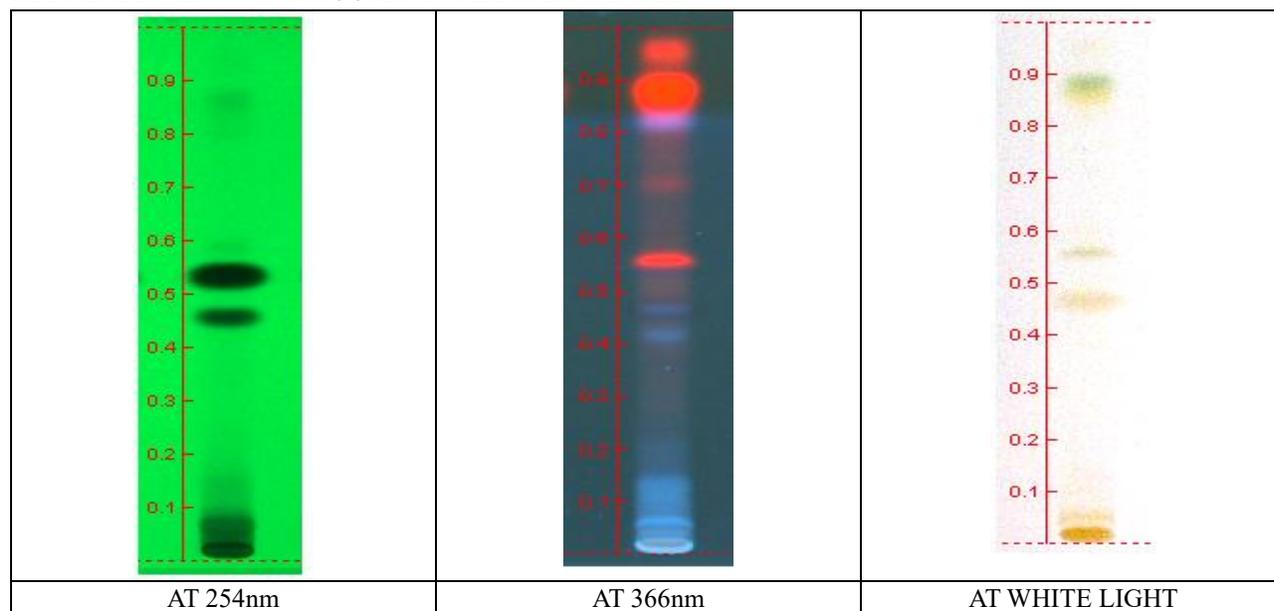
G. DERIVATIZATION

Iodine reagent.

TLC PROFILE

Image no:-6

TLC PLATE VIEWS OF *NIRGUNDI* SWARASAM SAMPLE



DERIVATIZED TLC PLATE VIEWS OF *NIRGUNDI* SWARASAM SAMPLE

Image no:-7

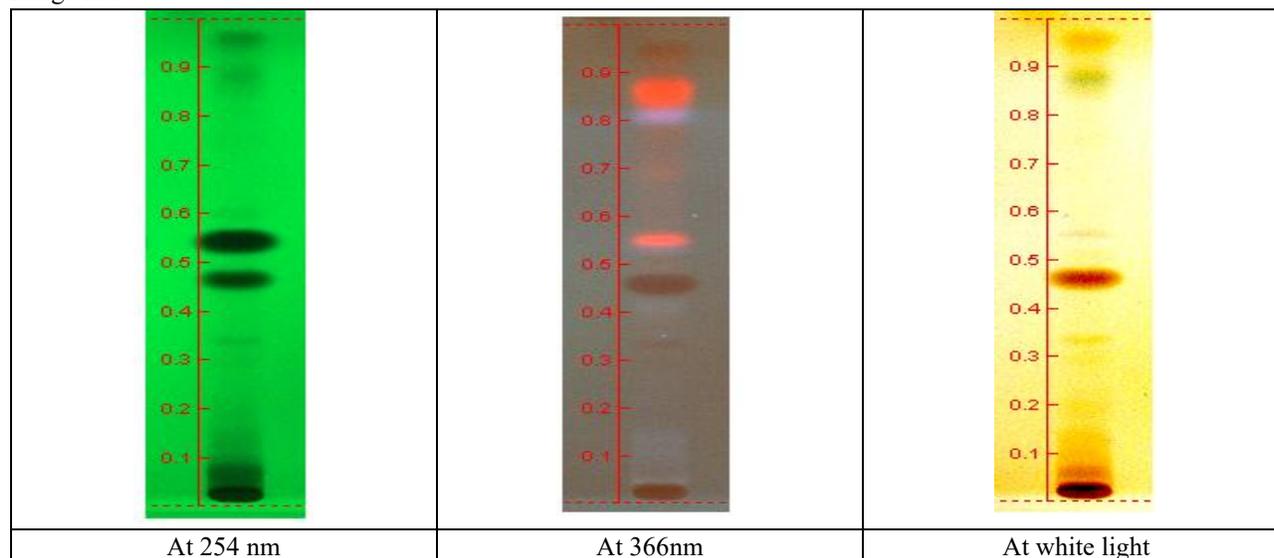


Table:- 5 Showing

Rf VALUE & % AREA OF *NIRGUNDI* SWARASAM SAMPLE AT 254nm

PEAK NO	Rf VALUE	AREA(AU)	% AREA(AU)
1	0.06	247.4	0.70
2	0.42	8006.0	22.50
3	0.50	21574.1	60.62
4	0.56	566.9	1.59
5	0.81	2534.3	7.12
6	0.85	2657.1	7.47

TOTAL PEAK NO – 06

TOTAL AREA – 35585.8 (AU)

Table:-6 Showing

Rf VALUE & % AREA OF *NIRGUNDI* SWARASAM SAMPLE AT 366nm

PEAK NO	Rf VALUE	AREA(AU)	% AREA(AU)
1	0.01	63.5	0.73
2	0.06	233.2	2.68
3	0.42	3047.4	35.00
4	0.51	890.8	10.23
5	0.56	945.2	10.85
6	0.87	2644.8	30.37
7	0.94	883.0.	10.14

TOTAL PEAK NO – 07

TOTAL AREA – 8707.9 (AU)

DISCUSSION

DISCUSSION ON PHARMACOGNOSTICAL STUDY

The sample *Vitex negundo* Linn. was collected from natural habitat. The authentication of *Vitex negundo* Linn. was done with the botanist. Pharmacognostical study reveals that *Vitex negundo* Linn. belongs to Verbinaceae family. Taxonomical study confirms plant Genus and Species status.

The dried powder of *Vitex negundo* Linn. showed light green colour and had characteristic smell.

Microscopic study of *Vitex negundo* Linn. Shows many non-glandular trichomes on adaxial surface. There are 3 to 4 layers of collenchymatous tissues, arc shaped prominent vascular bundles at the center, pericyclic cells with endodermal cells, radiated stomata and calcium oxalate crystals were observed.

Powder Microscopic study of *Vitex negundo* Linn. Showed the presence of oil globules, stone cells, palisade cells, oleo resins, phloem vessels and trichomes.

DISCUSSION ON ANALYTICAL STUDY

Prepared churna of *Vitex negundo* Linn. was subjected

for all the preliminary phyto-chemical studies, inorganic and organic tests. Physico-chemical parameters of *Vitex negundo* Linn. was estimated based on the methods.

Organic tests of *Vitex negundo* Linn. revealed the presence of alkaloids, flavanoides, phenols, tannins and saponins alcohol extract.

Inorganic compounds like Iron, Calcium, Potassium and Sulphate are present in *Vitex negundo* Linn.

Percent weight loss on drying or moisture content value was found to be in *Vitex negundo* Linn. (3.1%).

The value of moisture content of drugs could prevent bacterial, fungal or yeast growth through storage. The ash value, total ash in *Vitex negundo* Linn. Was 6.24%. Ash values used to find out quality, authenticity and purity of unsophisticated drug and also these are important quantitative standards.

HPTLC of leaf of *Nirgundi* has been standardized as per Phamacopoeial testing protocol. HPTLC photo documentation, Rf values and densitometric scan at 254nm, 366nm and after derivatisation has been developed. HPTLC leaf of *Nirgundi* in value may be the densitometric scanning at 254nm 6 peaks were found, among them the point with 0.50 Rf (60.62% area) value may be the major chemical constituents. At

366nm 7 peaks were found among them point with 0.87 Rf (30.37% area) may be the major chemical constituent.

DISCUSSION ON IN-VITRO STUDY

The present In vitro study was under taken to compare the anti microbial action of *Nirgundi* (*Vitex negundo* Linn.) on *Staphylococcus aureus* ATCC and *Klebsiella pneumoniae* ATCC. The Patra Swarasa of *Nirgundi* (*Vitex negundo* Linn.) were tested against *Staphylococcus aureus* ATCC and *Klebsiella pneumoniae* ATCC pneumonia by taking E.coli as control. These organisms are the main among enteric bacterial pathogens that cause Respiratory tract organisms. *Staphylococcus aureus* is a major cause of nosocomial infections and have become multidrug resistant in recent years.

Klebsiella pneumoniae is one of the important respiratory pathogen and the material called porins present in the outer membrane of Gram negative bacteria resist the diffusion of larger molecules into bacterial cytoplasm. Resistance of bacterial pathogens to existing antibiotics poses problems to clinicians in the treatment of microbial infections and efforts are made to identify antimicrobial material from natural traditional medicines. Search for newer more effective components is a continuing process.

- On the determination of MIC through Agar dilution study,
- At 100% & 50% concentrated Swarasa of *Vitex negundo* Linn. showed complete bacteriocidal activity on both *Klebsiella pneumoniae* ATCC and *Staphylococcus aureus* ATCC. The concentrated Swarasa were prepared according to Ayurvedic standards.
- At 25%, 12.5% and 6.25% concentration of Swarasa there was no inhibitory effect on *Staphylococcus aureus* and *Klebsiella pneumoniae*
 - The Time Kill assay showed the results:
- In time kill assay 100%, 50%, 25%, 12.5%, 6.25% dilutions of Swarasa of *Vitex negundo* Linn. showed inhibition to bacterial growth of

Staphylococcus aureus ATCC and *Klebsiella pneumoniae* ATCC in, 2 hour, 4hour, 6 hour, 8 hour and 24 hour in While on *Klebsiella pneumoniae*, standard organism shows growth from initial hour to 8 hour on all concentrations of 100%, 50%, 25%, 12.5%, 6.25% and shows no growth in 24th hour.

These observations showed that the Swarasa of *Vitex negundo* Linn. is showing antibacterial effect to both *Staphylococcus aureus* ATCC and *Klebsiella pneumoniae* ATCC, at first 3 concentrations (100%, 50%, 25%) prevents the exaggerated growth of *Staphylococcus aureus* and in last 2 concentrations shows the growth of the organisms. The first 2 (100%, 50%) concentrations only found to be effective on *Klebsiella pneumoniae* organism.

DESCRIPTION

Details of Drug

ETYMOLOGY – Nirukti¹²

‘निष्कास्य व्याधीन गुण्टयति शरीरंरक्षतीति।’

Nirgundi cures many diseases and protects the body.

MYTHOLOGICAL STORY OF *NIRGUNDI* - Uthpathi of Nirgundi:

It has a sacred status and is used in rituals in India; *Nirgundi* is considered as a sacred plant and is thought to have originated from the abdomen of Ganesha. The leaves are offered to Lord Shiva & Gouri on Nithya Somavara Vrata.

Vernacular names

Kannada: Nkkilu, Lakkigida

Telugu: Vaavili

Tamil: Nirkundi, Vellai-nochi

Hindi: Shivari, Nirgundi

Malayalam: Vellanocchi, karinochi

Assam: Aslok

Bengal: Nirgundi, Nishinda

Gujarati: Nagod

Marathi: Nirgundi

Punjabi: Sambhalu, Banna

Sanskrit: Nirgundi

English: Five leaved chaste tree

Table No:-7 Showing Synonyms of Nigundi by different Acharyas:

S. No	SYNONYMS	DhNi	Ka.Ni	Ra.Ni	B.P.Ni	Ada.Ni	Cha.S	Sus.S	Ash.H	Sd.Ni	Mp.Ni
1	Nirgundi	+	+	+	+	+	+	+	+	+	+
2	Sugandha										
3	Neelasinduk	+	+	+						+	+
4	Sindhuka	+	+	+	+	+				+	+
5	Bhuthakeshi		+	+						+	+
6	Neelika			+		+					
7	Indranika			+		+				+	
8	Shephalika				+	+					
9	Swetha pushpa	+			+	+				+	+
10	Neela pushpa	+	+	+						+	+
11	Sindhuvara	+			+	+	+	+	+	+	
12	Neela manjari									+	
13	Girisindhuka		+								
14	Seetha pushpa	+									
15	Sindhuvaraka	+								+	+
16	Sindhusaha		+								

Table 8:- Showing *Rasa Panchaka* of Nirgundi ^(8-13,18)

Grantha	B.N	K.N	S.N	R.N	M.N	D.N	P.N	N.R
<i>Rasa</i>								
<i>Katu</i>	+	-	+	+	+	+	+	+
<i>Tikta</i>	+	+	+	+	-	+	+	+
<i>Kashaya</i>	+	+	+	-	+	-	-	+
<i>Guna</i>								
<i>Laghu</i>	+	-	+	-	+	-	-	+
<i>Ruksha</i>	-	-	+	+	-	-	-	+
<i>Sheeta</i>	-	+	-	+	+	-	-	-
<i>Veerya</i>								
<i>Ushna</i>	+	-	+	+	-	+	+	+

Table 9:- Showing the *Karma* of Nirgundi [5-9, 11-13]

Karma	B.N	K.N	S.N	R.N	M.N	D.N	P.N	N.R
<i>Buddhida</i>	-	-	-	-	-	-	+	-
<i>Chakshushya</i>	-	+	-	-	-	-	-	-
<i>Deepani</i>	-	+	+	-	-	-	-	+
<i>Kandughna</i>	-	-	-	+	-	+	-	-
<i>Keshya</i>	+	+	+	-	+	-	-	+
<i>Krimighna</i>	+	+	+	-	+	+	+	+
<i>Kushtaghna</i>	+	+	+	+	+	+	+	+
<i>Medhya</i>	-	+	+	-	-	-	-	+
<i>Netrya</i>	+	-	+	-	+	-	-	+
<i>Shothahara</i>	+	+	+	+	+	-	+	+
<i>Shulahara</i>	+	+	+	+	+	-	+	-
<i>Smritiprada</i>	+	-	+	-	+	-	-	+
<i>Varnya</i>	-	-	+	-	-	-	-	+
<i>Vishaghna</i>	-	+	-	-	-	+	-	+

Morphology:

Vitex species shrubs or trees rarely woody lianas.

Stem: stem and branches obtusely quadrangular.

Leaves: leaves opposite, digitately palmately compound with 3-8 foliolate, rarely unifoliate, often aromatic or foetid, petiolate, exstipulate.

Inflorescence: inflorescence axillary or terminal dichasial cymes, lax diffuse panicles or corymbs, sessile or pedunculate, bracts narrow, linear around the size of the calyx.

Flowers: flowers bisexual, zygomorphic, hypogynous,

Calyx: calyx cupular or campanulate, 5 toothed rarely 3 to 6 or subtire.

Corolla: corolla hypocrateriform, 5 lobed, white, blue or purple, corolla tube straight or curved, usually villous inside and pubescent outside.

Stamens: stamens 4, didynamous, inserted above the middle of the tube, exerted, filaments filiform, anthers oblong or elliptic.

Ovary: ovary bicarpellary, 2-4 celled 1 ovule in each locule, hairy, style filiform, stigma bi-lobed, lobes equal.

Fruit: fruit drupaceous, endocarp hard, 4 seeded, seeds oblong or obovoid, nonendospermous.

PART USED:³⁷

Leaf, Root, Seed.

CHEMICAL COMPOSITION: (23,28,31)

Leaf

β -caryophyllene, caryophyllene oxide, globulol, sabinene, and viridiflorol as major constituents in Leaf.

Limonene, 1,8-cineole, citral, cinnamic aldehyde, eugenol, terpinen, sabinene and viridifloro.

p-cymene, *cis*-ocimene, citronellal, β -curcumene, β -caryophyllene, α -guaiene, guaia-3,7-diene, δ -guaiene, valencene, caryophyllene epoxide, ethyl-9-hexadecenoate, palmitic acid, (E)-nerolidol, humulene epoxide 1, globulol, humulene epoxide 2, epi- α -cadinol, α -muurolol, α -cadinol and α -bisabolol acetate represented about 85.5% of total composition of the essential oil of leaf.

Image No:- 8 Showing Useful parts of Nirgundi (*Vitex negundo* Linn.)



CONCLUSION

- Under the name *Nirgundi*, drugs from source namely, *Vitex negundo* Linn. (Verbenaceae).
- *Nirgundi* possesses Laghu, Rooksha Guna and Katu Tikta, Kashaya Rasa, Katu Vipaka and Ushna Veerya. It is Vata kaphahara action, Kasa swasaghna, krimighna and Sophahara.
- In microscopic study of Patra of *Vitex negundo* Linn. Showed, single layered epidermis composed of thin walled cells covered by thin cuticle. The cuticle is composed of collenchymatous cells, followed by parenchymatous cell. Each vascular bundle is

capped by pericycle. vessels are arranged radially in groups of 3-4.

- Powder Microscopic study of *Vitex negundo* Linn. showed the presence of polygonal thin walled straight epidermal cells, spiral vessels, tubercle based unicellular hairs and paracytic stomata.
- Phytochemical study reveals Reducins sugars, flavanoids, Phenols and tannins are active principle present in *Vitex negundo* Linn. Phenolic compound, flavonoids, volatile oils, saponins and tannins are mainly responsible for its antimicrobial activity.
- The present study revealed good antimicrobial

results from patra swarasa of *Vitex negundo* Linn.

- In Agar dilution method and time kill assay of patra swarasa of *Vitex negundo* Linn. showed inhibition of growth of *Staphylococcus aureus* and *Klebsiella pneumonia*.
- The study shows that patra swarasa of *Vitex negundo* Linn. is more effective against *Staphylococcus aureus* than *Klebsiella pneumonia* which are responsible for respiratory tract infections in common.

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