



Rediscovering Conkerberry (*Carissa Lanceolata*): A traditional ethanobotanical treasure

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Abstract:

Carissa lanceolata is a genus which belongs to Apocynaceae family with about two fifty genera which consists of about thirty six species as evergreen shrubs to native topical and subtropical regions across Africa, Asia or Oceania. *Carissa lanceolata* (Conkerberry) is a woody shrub which was used in traditional medicines by various indigenous communities like Australia and Queensland.

C. lanceolata plays various pharmacological activities like anti-inflammatory, anti-oxidant, anti-microbial, anti-cancer, anti-pyretic, anti-arthritic activity, wound healing, anti bacterial, anti urinary tract infection and analgesic activity. Traditionally it was used for toothache, respiratory infections and wound healing. Various chemical constituents and bioactive compounds are obtained from *C. lanceolata* like Volatile oil, Flavonoids, Phenolic Compounds, Triterpenoids etc .

It is a small, thorny shrubs which can reach a height of three meters which has bright green in appearance and when the fruit ripens shows bluish-black colour. The flowering of *Carissa Lanceolata* occurs typically between September and December. They have small, starry-white flowers having fragrance which forms resemblance to Jasmine. The different extracts contains potential agents with activities against many diseases.

Keywords:

Traditional uses, *Carissa lanceolata*, phytochemicals constituents, anti-inflammatory activities.

Abbreviation:

DCM- Dichloromethane, MeOH-Methanol, EtOAc-Ethyl acetate, EtOH- Ethanol, MIC- Minimum Inhibitory Concentration, NMR- Nuclear Magnetic Resonance, ¹H- Proton, ¹³C- Carbon 13 isotope, TLC-

Thin Layer Chromatography, GC- Gas Chromatography, MS- Mass Spectroscopy, GC-MS – Gas Chromatography with mass selective detector, IR- Infrared Spectroscopy, UV- Ultraviolet, ppm- Parts per million IC50- Inhibitory Concentration required for 50% inhibition

1.Introduction:

Carissa Lanceolata (Family Apocynaceae) is also known as Conkerberry which is distributed in the topical and sub topical region of Africa and Asia. The Apocynaceae is also known as Dogbane Family. The species: *Carissa* has been widely utilised in traditional medicines for treating various diseases such as headache, stomach pain, diabetes, cardiac diseases, asthma, rheumatism, syphilis, rabies and gonorrhea.

The various studies have been performed to study the pharmacological activities of *Carissa L.* The scientific studies validated activities like anti-inflammatory, anti-oxidant, anti-microbial, anti-cancer, anti-pyretic, cardio protective, wound healing and anti-diabetic properties.

The scientific studies of *Carissa* species have been found to contain a numerous bioactive compounds, like polyphenols(flavonoids and phenolic acids), lignans, terpenoids, steroids, coumarins and cardiac glycosides.

Several compounds such as lupeol, carrisol, naringin, carrissone, scopoletin and ursolic acid are found in *Carissa L.* In addition the fruits are packed with essential nutrients like proteins, carbohydrates, dietary fibers, Vitamin C and variety of macro and micro elements which make them a valuable in nutraceutical application. [1]

As the species *Carissa Lanceolata* is mostly found in the wild regions of AUSTRALIA below are there local names.

Table no.1

Regions	Common names
Mayi Yapi Tribe(Queensland, Australia)	Kanggaparri

Yindjibarndi(Pilbara Western Australia)	region, Djurali
Central Australia	Anwekety
Indigenous Australian name	Nganango
Southern Africa	Num-Num

[2]

Image 1: Herbarium charts of *C. lanceolata*

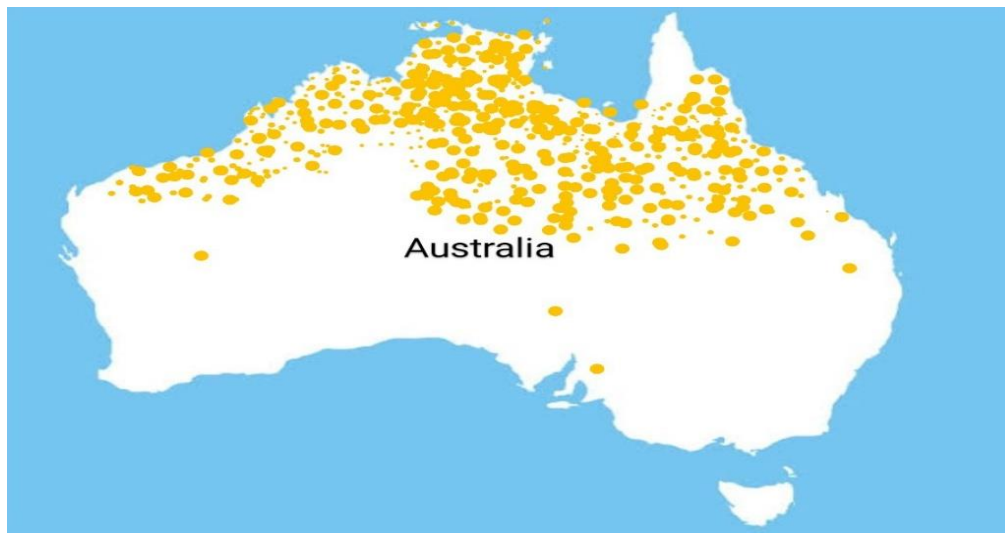


Image 2: Geographical distribution of C. Lanceolata



Image no. 3 Whole plant

General description:

It is a spiny shrub which can grow up to three meters tall. The stems are generally weak and decumbent. The plant usually grows in red to reddish-brown sand, limestone and grey clay.[3]

Leaves:

Leaves of *C. Lanceolata* are bright green in colour. They are opposite and simple. The leaves have glabrous or sparsely hairy texture. The shape ranges from narrow ovate to lanceolate. The length of the leaves is between one to five cm long.

Flowers:

They have small, starry-white flowers having fragrance which forms resemblance to Jasmine. The sepals are ovate to narrowly ovate, about $1.5-3 \times 0.4-1.5$ mm. The corolla is white in colour with a tube in length of 5-21.5 mm; the lobes are of 1.5-15 mm long and ovate. The flowering of *Carissa Lanceolata* occurs typically between September and December.[4]

Fruits:

C. Lanceolata produces tiny edible fruits which are initially green when unripe but turns bluish-black when are ripped; having a glabrous outer appearance . The fruits are about one inch longer and they grow in large quantity after the rainy season. The size of fruits are about 3-60 mm long and 3-60 mm in diameter.

Toxicity of unripe fruit:

The green fruit of *carissa* is toxic but the detailed studies on the toxicity is limited. The toxicity is aligned with some of the chemical constituents like alkaloids and glycosides present in the unripe fruits. These compounds can affect if consumed unripe in humans and animals. Once the fruits of the *Carissa* species are riped and become edible then they lose their toxic properties.

Habitat:

C. Lanceolata are found in the regions of Australia and Queensland. They are usually grown in the open forests, flood plains and rocky ridges. They are grown at elevation ranging from sea level to nine hundred meters.[5]



Image 4. Leaves



Image 5. Flowers



Image 6. Unripe fruit



Image 7. Ripe fruit



Image no.8 Root



Image no.9 Bark

2.Ethanobotanical Uses:

Carissa Lanceolata has been widely used in early time, they were traditionally used by indigenous Australian communities for different medicinal purposes.

1.Pain relief:

The C. Lanceolata was been used to alleviate muscle and joint pain with the help of extract.

2.Cold and flu Remedies:

To manage the symptoms of colds and flu the decoction of the plant was done.

3.Wound healing

The topical application of the C. Lanceolata plant was done on the clean wounds.

4. Respiratory issues

C. Lanceolata was used for chest complaints, which provides potential benefits for respiratory issues.

Table no .2 Classification of *Carissa lanceolata*

Kingdom	Plantae
Phylum	Charophyta
Class	Equisetopsida
Subclass	Magnoliida
Superorder	Asteranae
Order	Gentianales
Family	Apocynaceae
Genus	Carissa
Species	Carissa Lanceolata R.Br.

3.Genus Carissa:

The genus carissa , belonging to the Apocynaceae family of the Gentianales order , comprises a diverse range of plants having significant medicinal value. [6]

Table no.3 Ethanopharmacological use of various *Carissa* species

Species	Part used	Chemical constituents	Ethanopharmacologic al uses
C. Lanceolata	Bark	Flavonoids, Terpenoids, Cardiac glycosides	Toothache, Respiratory infection

C. Carandas	Roots	Terpenoids, Steroids, Cardiac glycosides, Sesquiterpens	Stomachic, Vermifuge, Insect repellent
	Stem	Sesquiterpens Glucoside, Lignans	Strengthens tendons
	Leaves	Triterpenoids, Steroidal Glycosides, Phenolic Compounds, Tannins, Flavonoids	Fever, earache, diabetic ulcer
	Whole plant	Flavonoids, Steroids, Alkaloids, Triterpenoids, Cardiac glycosides, Saponins	Diarrhoea, mouth ulcer, epilepsy, burning sensation, stomach disorder, rheumatism, syphilitic pain, anorezia
C. bispinosa	Root	Triterpenoids, Cardiac glycosides, Sesquiterpens	Toothache, ornamental
C. edulis	Roots and leaves	Sesquiterpens, Volatile compounds, Phenolic Compounds, Benzodiazepine Analogues	Reduce blood glucose level, stomach pain, toothache, anti helminthic
C. congesta	Ripe Fruit	Phenolic Compounds, Flavonoids, Triterpenoids, Vitamins, Sugars	Puddings and jellies, tanning, dying, biliousness

	Root	Triterpenoids, Cardiac glycosides, Sesquiterpens, Flavonoids	Fly repellent, bitter stomachic and itches
	Unripe fruit	Triterpenoids, Flavonoids, Phenolic Compounds	Astringent
C. Opaca	Fruits and leaves	Polyphenols, Terpenoids, Steroids, Flavonoids and Cardiac glycosides	Jaundice, hepatitis, fever and asthma
	Roots	Triterpenoids, Phytostreols, Flavonoids, Phenolic Compounds, Vitamins	For treating Wounds and injuries

Common Names of Carissa species

Table no. 4 Common names

Scientific names	Common Names
C. Lanceolata	Conkerberry (English)
C. Grandiflora	Natal Plum
C. Carandas	Cranberry (English)
C. Congesta	Karamcha, Karancha(Bengali), Karaunda(English)

C. Bispinosa	Num-Num(English)
C. Ovata	Currant bush, Kunkerberry, Karey
C. Tetremera	Sand Num-Num

4. Microscopical characteristics:

•Epidermis:-

➤ Structure:

The outermost layer is made up of a single row of compactly arranged cells.

➤ Protection:

Presence of thick cuticle.

➤ Function:

Cuticles helps to reduce water loss which prevents the dehydration.

•Cortex:-

➤ Structure: Composed of parenchymatous cells having intercellular spaces.

➤ Special features :It may contain laticiferous canals.

➤ Function: Produce milky latex.

•Vascular bundles:-

➤ Vascular bundle arrangement: Collateral and Open Vascular bundles are arranged in a ring form.

➤ Phloem location: They are located in the outer side.

➤ Xylem location: They are located in the center.

➤ Cambium Presence: They are located between xylem and phloem.

•Pith:-

➤ Central Region Composition: They consists of large, thin walled parenchymatous cells.

➤ Function: They are stored in nutrients and they provide support to the structure.

•Special features:-

➤ Calcium oxalate crystals: Druses or raphides may be present in the pith or cortical cells.

- Distribution of Laticifers: They are scattered throughout the cortex and vascular regions.
- Function of Laticifers: They produce latex.[7]

5.Extraction process of C. Lanceolata:

A. Collection and Preparation

- Collect the leaves, roots ,wood or any other part of plant(C. Lanceolata). Wash them thoroughly with clean water to remove the dirt or any impurity.
- Dry the plant material by any of the drying method(Sun dry, Shade dry or Air Oven) at controlled temperature of 40-50°C to preserve the bioactive compounds; as high temperature can cause decomposition of bioactive compounds.

B. Grinding:

- Grind the dried plant material in fine powder using Mortar and Pestle or Mechanical Grinder.
- Sieve the powder for uniform particle size.

C. Solvent Extraction:

- Choice a appropriate solvent: Use solvents like Ethanol, Methanol, Water or Dichloromethane.
- Extraction methods:
 - Maceration:- Soak the powdered material in solvent for 24-72 hours at room temperature with occasional stirring.
 - Soxhlet Extraction:- Using Soxhlet apparatus with suitable solvent at controlled temperature.
 - Ultrasound Assisted Extraction:- This method is used for faster and more efficient extraction.

D. Filtration:

- Filter the obtained extract using Whatman Filter Paper or Vacuum Filtration to separate the liquid extract from the solid cake.

E. Concentration:

- The filtrate is concentrated using the rotary evaporator under reduced pressure which is necessary to remove the solvent and obtain the crude extract.

F. Fractionation (Optional):

- The crude extract are partitioned into different solvent fractions (e.g., hexane, ethanol, ethyl acetate or water) to isolate different bioactive compouds.

G. Purification:

- For the purification of individual compounds the chromatographic techniques like Thin Layer Chromatography (TLC), Preparative TLC or Column Chromatography.
- Advanced purification techniques can also be used like High-Purification Liquid Chromatography (HPLC).

H. Characterization:

- The analysis of obtained purified compounds are done using spectroscopic methods:
 - Nuclear Magnetic Resonance (NMR)
 - Infracted Spectroscopy (IR)
 - Gas Chromatography-Mass Spectroscopy (GC-MS)

I. Storage:

- The extract or isolated compounds is stored in airtight containers at low temperatures as it prevents the degradation.

[8]



Fractionation is done and then the purification is done using chromatography techniques



Extraction

Plant material are collected and washed thoroughly to remove dirt

Dry the plant material and grind the plant material into fine powder

The extraction is done using various methods like Maceration or Soxhlet extraction by selecting appropriate solvent

Filter the extract using Whatman filter paper or Vacuum filtration

Use rotary evaporator to remove solvent and obtain a semi-solid crude extract



7. Pharmacological activities:-

A. Anti inflammatory activity:

The scientific studies are done of the extracts from *C. Lanceolata* which shows anti-inflammatory effects as it contain bioactive compounds like (+)-carissone and dehydrocarissone which are responsible in exhibiting significant anti-inflammatory effects by inhibiting the production of inflammatory mediators such as bradykinin and prostaglandins which reduces inflammation.

The suppression of cyclooxygenase (COX) enzymes and production of nitric oxide is done to show anti-inflammatory effect. The comparative studies are done to study the anti-inflammatory effects of *C. Lanceolata* with standard NSAIDs like Indomethacin which shows promising results with less side effects.[10]

B. Anti-oxidant activity:

C. Lanceolata consists of presence of high levels of bioactive compounds like flavonoids and phenolic compounds which are famous for their anti oxidant properties. The help by scavenging free radicals and importantly reduces the oxidative stress.

The various studies have used various assays including the DPPH(2,2-diphenyl-1-picrylhydrazyl) and ABTS(2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)) which are done to evaluate the anti oxidant capacity.

The IC 50(**Inhibitory Concentration 50%**) value from extract has been reported by demonstrating effective radical scavenging abilities. The *C. Lanceolata* extract shows IC50 value compared to standard anti-oxidant likes Ascorbic acid and Trolox. The plant extracts have shown stability in anti oxidant capacity under various conditions which indicates its potential for use in food and cosmetics.

C. Anti-Bacterial Activity:

The *C. Lanceolata* extract of roots and wood exhibit potent antibacterial properties which effectively inhibit the growth of both Gram -positive and Gram-negative bacteria including notable pathogens like *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*.

The isolation of key bioactive compounds from the plant such as eudesmane-type sesquiterpens, including carissone, dehydrocarissone and carindone are done. These compounds exhibit antibacterial efficacy with MIC(**Minimum Inhibitory Concentration**) Value under 0.5 mg/ml against the tested bacterial strains.

Anti-bacterial potential was determined via micro-broth dilution assays which highlights the potency of the crude extracts and isolated compounds in inhibiting bacterial growth.[12]

Table no 5. Anti-bacterial potential of *Carissa Lanceolata*

Carissa Species	Plant part used	Extract/Compound	Microorganisms	MIC(mg/mL)
Carissa Lanceolata	Root and Wood	Methanol, Dichloromethane(DCM)	Staphylococcus aureus and Escherichia coli	•Dehydrocarissone : <0.5 mg/ml •Carindone: >1 mg/ml •Carrisone: 0.1-0.5 mg/ml
			Pseudomonas aeruginosa	•Dehydrocarissone: 1-2mg/ml •Carindone: >1 mg/ml •Carissone: 1-2 mg/ml

Note: 2'- Hydroxy Acetophenone exhibit the strongest antibacterial activity amongst the isolated compounds.

- The DMC extract of the plant (wood and root bark) is the most effective against the Gram-positive and Gram-negative bacteria.

[13]

D. Analgesic Activity:

The extracts from various parts of the C. Lanceolata mainly roots, leaves and fruits have shown significant analgesic effects in animal studies. The extract from fruit showed the highest analgesic effect, followed by seeds, leaves, root bark and stem bark.

In the studies, the oral administration of extracts at doses of 50, 100 and 150 mg/kg the body significantly reduced the pain responses. At 100 mg dose the analgesic activity was observed, the comparative studies were performed to that of the standard analgesics like Aspirin (Acetylsalicylic acid).

The analgesic activity are presumed to occur by inhibiting the inflammatory pathways and altering pain perception, resembling the mechanism similar to NSAIDs(**Non-Steroidal Anti Inflammatory Drugs**).[14]

E. Hepatoprotective Activity :

Carissa Lanceolata have been investigated for its hepatoprotective effects, highlighting its potential in protecting the liver damage and efficacy against Hepatotoxicity. The extracts from plant material have shown significant hepatoprotective properties. In animal models ,the effect against liver damage induced by toxins like carbon tetrachloride (CCl₄) and paracetamol was noticed.

The hepatoprotective activity acts by

- reducing the lipid peroxidation i.e, it prevents the oxidative damage to liver cells.
- lowers bilirubin levels i.e, it indicates the improved liver function.
- enhances level of antioxidant enzymes i.e, Glutathione (GSH) neutralizes the free radicals and Superoxide Dismutase(SOD) converts Superoxide radicals into the less harmful substances.
- Anti-oxidant action and stabilization of membrane shows protective action against liver cells.

The presence of bioactive compounds like Phenolic acids and flavonoids in the C. Lanceolata extract plays an important role in liver cells protection by oxidative stress. [15]

F. Anti diabetic activity:

As limited studies on anti diabetic activity are done as compared to other species of Carissa like Carissa Carandas and Carissa Opaca. The extracts from roots or fruits are obtained from solvents like Methanol, aqueous decoction or ethanolic fractions are used.

The extracts show their anti diabetic activity by

- It inhibits the pancreatic alpha-amylase activity, that reduces the carbohydrate breakdown and glucose absorption in the Carissa Species i.e, C. Opaca.
- It enhances the glucose uptake in peripheral tissues and improves the insulin sensitivity in C. Carandas.[16]
- It protects pancreatic beta-cells from damage which is induced by Streptozotocin(STZ), as studies indicate in animal models.

The animal studies indicates that the STZ-induced diabetic rats, from the fruit extract from C. Carandas using ethanolic solvent at doses of 200 mg/kg and 400 mg/kg reduces blood glucose levels (BGL) as compared to the standard anti diabetic drugs such as Metformin.[17]

The animal studies also indicates that extract from C. Opaca roots by using methanolic extracts shows moderate Inhibitory alpha-amylase activity with IC₅₀ value between 5.38-7.12 mg/mL.

The high anti oxidant activity partly attributes to the anti diabetic effect as the high anti oxidant potential helps neutralize oxidative stress which is linked to diabetes. They prevents the pancreatic beta-cell damage, enhances the insulin sensitivity and mitigates diabetes-related complications.[18]

G.Anti Pyretic Activity:

The leaves and root extract of *C. Lanceolata* have been studied for its anti pyretic activity. In studies commonly used solvents such as methanol, aqueous and n-hexane.

The extract show anti pyretic activity by inhibiting prostaglandin synthesis by reducing fever by blocking the pyrogenic signals. The mechanism is similar to NSAIDs by lowering body temperature by interfering with inflammatory pathways.

H.Wound healing :

The root extract are majorly used for wound healing activity using solvents like methanolic and diethyl ether. The methanolic root extract of *C. lanceolata* shows inhibiting action against bacterial strains, highly reactive against *Pseudomonas aeruginosa* (20mm) and moderately active against *E. coli* (10mm).

Different species in the studies indicates that the extract are non-toxic at doses upto 5000 mg/kg which makes it safe for topical or systemic use.[19]

I. Anti Arthritic activity:

The anti arthritic activity of *C. lanceolata* has not been studied specifically in available literature, but the other species of *Carissa* like *C. carandas* and *C. spinarum* have been studied for their activity in managing arthritis. The roots and leaves extract of *C. carandas* and *C. spinarum* by methanolic and ethanolic extract are primarily studied in experiments.

The show their activity by inhibiting the pro-inflammatory mediators by reducing the cytokines like TNF- α and IL-6. They also acts by neutralizing the free radicals that contribute in the joint inflammation and damage and it also decrease leukocyte migration and suppresses the lymphocyte proliferation.

The phytochemicals responsible for the anti arthritic activity are flavonoids, lanostane, triterpenoids and phenolic acids.

The studies like Freund's adjuvant-induced arthritis model have been done on species of *Carissa*

- Carissa spinarum* : Ethanolic root extract of 100, 200 and 400 mg/kg reduced paw edema and joint swelling.

- Carissa carandas: Ethanolic leaf extract of 200 and 400 mg/kg was demonstrated for its dose-dependent reduction in paw volume, compared to standard drugs like Aspirin (50 mg/kg).

J. Anti Cancer Activity:

The root extract of *C. lanceolata* and related species have been studied for their cytotoxic effects, while the leaves and fruits of methanolic extract from related species shows anti cancer properties. The phytochemicals constituents which shows anti cancer activity are:

Table no. 6

Phytochemical constituents	Activity
Carandinol	It is a triterpene which is isolated from Carissa carandas leaves that shows cytotoxic effects against the cervical and prostate cancer cell lines (IC ₅₀ =6.87)
Ursolic acid and Betulinic acid	It is found in Carissa carandas these induces programmed cell death(Apoptosis) that helps eliminate cancer cells
Lanostane triterpenoids	They are isolated from fruits, and they show cytotoxic effects

The other species shows cytotoxic effects from species like *C. carandas* and *C. spinarum* with its methanolic extract, it inhibits cancer cell lines in different types of cancers like:

- Breast cancer(MCF-7):IC₅₀=56.72
- Lung cancer(HL-60):GI₅₀=34.58

[20]

8. Chromatographic and Spectroscopic Methods:

A. Thin Layer Chromatography (TLC):

It is used to profile extract, column fraction and to isolate by comparing R_f value. **Stationary Phase** used is Silica gel F254 aluminium-backed plates. **Mobile Phase used** are various solvent systems, including hexane, ethyl acetate, methanol, chloroform and petroleum ether. **Visualization** is done in UV light (254 & 366 nm), anisaldehyde spray, sulfuric acid iodine vapour. **Application:** Linomat IV autosampler or manual spotting.

B. Column Chromatography:

Stationary Phase used is Silica gel (60-120 mesh) and neutral alumina. **Mobile Phase** used is Gradient systems with increasing concentrations of DCM, EtOAc, MeOH and hexane.

C. Preparative TLC:

It is used to isolate pure compounds from the selected fractions which is developed with **Solvent System** and visualised with anisaldehyde spray. The bands which contains the required compounds were scraped, extracted with DCM, and then purified.

D. Gas Chromatography – Mass Spectroscopy (GC-MS):

It is used to identify thermostable and volatile compounds. **Instrumentation** used is Hewlett Packard 5890 GS with an HPMS 5 Column. **Conditions** required are (i) Carrier Gas: Helium (0.9 mL/min, 7.0 psi) (ii) Temperature Gradient: 60°C to 250°C over 26 minutes (iii) Detector Temperature: 280°C. **Data Analysis** are identified using HP Chem Search Libraries (Wiley 275).

E. Spectroscopic Analysis:

• Infrared Spectroscopy (IR):

It is conducted using Fourier Transform IR Spectroscopy, the samples are dissolved in DCM or acetone and is analysed using NaCl discs.

• Mass Spectroscopy (MS):

It is conducted on GC-separated fractions which is done using Hewlett Packard Mass Selective Detector 5971.

• Nuclear Magnetic Resonance (NMR) Spectroscopy:

The preliminary analysis is recorded using a Varian Gemini 200 MHz NMR spectrometer, the detailed analysis is done by ¹H and ¹³C NMR spectra is recorded on a Bruker Advance 500MHz NMR spectrometer and the solvent used are deuterated chloroform (d-CHCl₃) and deuterated acetone (d₆-acetone).[30]

9. Chemical tests:

The basic chemical tests are done to identify the presence or absence of chemical constituents in extracts.

Table no. 7 Chemical tests for Root bark

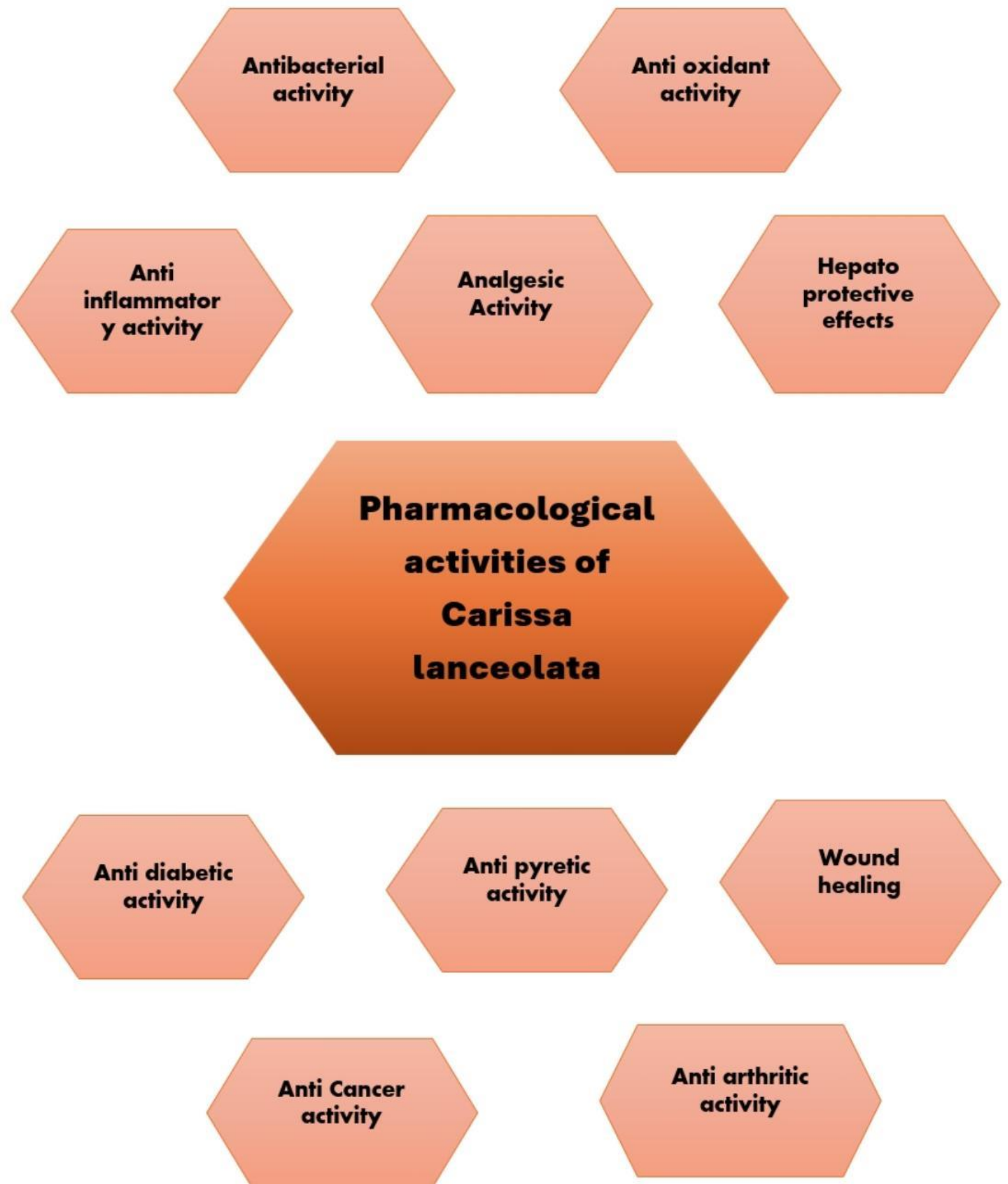
Solvent	Alkaloids		Phenolic Compounds	Cardiac glycosides	Steroids	Saponins	Anthraquinones
	Dragendorff's	Mayor's	FeCl ₃	Keller-Killani	Lieberman – Burchard Test	Froth Test	Borntrager's Test
Hexane	Nil	Nil	Nil	Nil	Nil	Nil	Nil
DCM	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Methanol	+++	++	++++	Positive	Positive	2ml in 0 min, 1ml in 10 min	Nil

Table no. 8 Chemical tests for Root wood

Solvent	Alkaloids		Phenolic Compounds	Cardiac glycosides	Steroids	Saponins	Anthraquinones
	Dragendorff's	Mayor's	FeCl ₃	Keller-Killani	Lieberman – Burchard Test	Froth Test	Borntrager's Reaction
Hexane	+	Nil	Nil	Nil	Nil	Nil	Nil
DCM	+	+	+	Positive	Positive	Nil	Nil
Methanol	++++	+++	+++	Positive	Positive	Nil	Nil

+:faint,++:clear,+++:very clear,++++: highly intense

[26]



10. Conclusion:

In conclusion, the *Carissa lanceolata* as a plant with various medicinal properties which is validated by the traditional uses and has supported by the scientific research. As the various studies have backed the anti-inflammatory, anti-oxidant, anti-microbial, anti-cancer, anti-pyretic, anti-arthritis activity, wound healing, anti bacterial and analgesic activity. The different extracts contains potential agents with activities against many diseases. Some of these agents are isolated and we must isolate and identify for many possible agents that can cure against various diseases.

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Thanks again to all.

Future Scope:

1. Study of potential modulating inflammatory pathways and oxidative stress at the cell level.
2. Perform clinical and preclinical studies to study the safety and efficacy for human use in treatment of diabetes, wounds and cancer.
3. Assessment of the toxicity of extracts and chemical compounds for safe application.
4. Documentation of the traditional preparation methods used in indigenous communities.
5. Development of pharmaceutical formulations like ointments for wound healing, capsules for hepatoprotective effects.
6. Explore the nutraceutical field.
7. Investigation of the suitable and sustainable cultivation methods to ensure the consistency in the supply of plant material.
8. Exploring the potential formulations in skincare products.
9. Exploring the detailed mechanism for non explored activities.

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