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APPROVED MEDICINAL PLANTS WITH ANTICANCER PROPERTIES: A COMPREHENSIVE REVIEW

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ABSTRACT

As one of the top causes of death globally, cancer warrants the investigation of alternative and complementary therapeutic strategies. Bioactive compounds of anticancer potential are found in various medicinal plants for many centuries. In this review, we review the anticancer activities of various medicinal plants, their secondary phytochemical constituents which are engaged in anticancer activity, mechanism of action and therapeutic efficacy. References to the major compounds including alkaloids, flavonoids, terpenoids, and polyphenols that play important roles in the induction of apoptosis, inhibition of angiogenesis, and modulation of signaling pathways are described. The review also outlines the challenges faced in developing plant-based anticancer drugs, which include standardization, bioavailability, and toxicity. Medicinal plants hold great promise as a source of new anticancer agents, but further studies are needed in order to translate their traditional use into contemporary therapies.

Keywords: Medicinal Plants, Anticancer Properties, Phytochemicals, Apoptosis, Angiogenesis, Bioactive Compounds.

1. INTRODUCTION

Cancer is a heterogeneous and multistep disease that manifests through uncontrolled cellular growth and metastasis (Hanahan & Weinberg, 2011). In spite of significant progress with conventional therapies like chemotherapy, radiation, or immunotherapy, there remains a need for more effective, less toxic treatment (DeVita & Chu, 2008). Widespread use of medicinal plants as therapeutic agents in traditional medicine systems has led to a wealth of bioactive compounds with therapeutic potential (Newman & Cragg, 2020). Ongoing scientific studies have confirmed the cancer-suppressing potential of several medicinal plants, indicating their cytotoxic activity against cancerous cells without harming healthy ones (Cragg & Pezzuto, 2016; Atanasov et al., 2021). This review aims to give an insight into the best-studied medicinal plants capable of exhibiting anticancer activity in vivo and in vitro, revealing the mechanisms of action of these plants along with their therapeutic potential in modern oncology (Gali-Muhtasib et al., 2015). This article demonstrates that plant-based therapies offer interesting potential to alleviate the global burden of cancer if traditional knowledge is integrated with contemporary research (Yuan et al., 2016).

2. MEDICINAL PLANTS USED IN CANCER

Scientific Name – ***Catharanthus* roseus**

Local Name – **Madagascar Periwinkle**, **rose periwinkle, bright eyes.**

Taxonomic Hierarchy –

- Kingdom: Plantae
- Sub Kingdom: Tracheobionta (Vascular plants)
- Division: Magnoliophyta
- Class: Magnoliopsida
- Subclass: Asteridae
- Order: Gentianales

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- Family: Apocynaeean (Dog-bane family)
- Subfamily: Plumeroideae

Phytochemicals –

- **Alkaloids:** Vinblastine, Vincristine, Vindoline, Catharanthine, Ajmalicine
- **Flavonoids:** Kaempferol, Quercetin
- **Phenolics:** Caffeic acid, Ferulic acid
- **Terpenoids:** β-Sitosterol, Lupeol.

Vernacular names

Catharanthus roseus, during the course of its spread and naturalization over the tropics and subtropics has acquired a diversity of vernacular names as shown in the table:

Country	Vernacular name(s)
England	Madagascar periwinkle
India	Cape – periwinkle, Church yard blossom, Dead-man's flower, Ainskati, Rattanjor, Sadaphul, Sudukad umullai, Billagannerue (Telugu) Bara Massi and Sada Bahar (in Hindi), Gulfering (Kashmiri), Nayantara (Bengali).
Indonesia	Indische maagdepalm, Kembang saritijha, Kembang – dembaga.
Japan	Nichinchi
Philippines	Chichirica
West Indies	Oldmaid, Ramgoat rose, Jasmine, Magdalena, Vicaria
Sri – Lanka	Minimal or Patti-poo
Thailand	Phaeng phoi farang or Phang-puai-fa-rang
Venda	Liluvha
Vietnam	Dua can
Bangladesh	Nyantra
USA	Periwinkle
Pakistan	Sada-bahar
Mexico	Ninfa
Brazil	Boa-noite

Plant parts used for extraction of Alkaloids:

Plant parts	Name of Alkaloids
Leaf	Catharanthine, Vindoline, Vindolidine, Vindolicine, Vindolinine, ibogaine, yohimbine, raubasine, Vinblastine, Vincristine.
Stem	Leurosine, Lochnerine, Catharanthine, Vindoline.
Root	Ajmalacine, Serpentine, Catharanthine, Vindoline, Leurosine, Lochnerine, Reserpine, Alstonine, Tabersonine, Horhammericine, Lochnericine, echitovenine. (Shanks et al.1998)
Flower	Catharanthine, Vindoline, Leurosine, Lochnerine, Tricin (Flavones).

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Alkaloids possessing anticancer property, mechanism and its clinical uses:

Vinca Alkaloid	Mechanism of Action	Clinical Uses
Vincristine	Binds to tubulin, inhibiting microtubule formation, and arrests cell division in metaphase.	Leukemia, lymphomas
Vinblastine	Inhibits microtubule polymerization, preventing mitotic spindle formation and cell division.	Hodgkin's disease, testicular germ cell cancer
Vinorelbine	Semi-synthetic derivative that disrupts microtubule assembly, blocking mitosis.	Solid tumors, lymphomas, lung cancer
Vindesine	Binds to tubulin, inhibiting microtubule formation and preventing cell division.	Acute lymphocytic leukemia

Scientific Name - ***Taxus brevifolia***

Local Name – ***Pacific and European Yew***

Taxonomic Hierarchy –

- **Kingdom:** Plantae
- **Division:** Angiosperms
- **Class:** Dicotyledons
- **Order:** Pinales
- **Family:** Taxaceae
- **Genus:** *Taxus*
- **Species:** *Taxus brevifolia*

Phytochemicals –

- **Alkaloids:**
  - **Taxol (Paclitaxel) – Used in cancer treatment.**
  - **Taxinine – Potential anticancer properties.**
- **Flavonoids:**
  - **Quercetin – Antioxidant.**
  - **Kaempferol – Anti-inflammatory, antioxidant.**
- **Terpenoids:**
  - **Taxanes – Includes paclitaxel, effective in chemotherapy.**

Country/Region	Vernacular Name(s)
United States	Pacific Yew, Western Yew, Oregon Yew
Canada	Pacific Yew, Western Yew
United Kingdom	Pacific Yew
Germany	Pazifische Eibe

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Country/Region	Vernacular Name(s)
France	If de l'Ouest, If du Pacifique
Spain	Tejo del Pacífico
Italy	Tasso del Pacifico
Portugal	Teixo-do-Pacífico
Netherlands	Pacifische Taxus
Russia	Тис тихоокеанский (Tis tikhookeanskiy)
China	短叶红豆杉 (Duǎn yè hóngdòu shān)
Japan	パシフィックイチイ (Pashifikku Ichii)
India	Pacific Yew (English), पैसिफिक यू (Paisifik Yū)
Brazil	Teixo-do-Pacífico
Mexico	Tejo del Pacífico
Australia	Pacific Yew
New Zealand	Pacific Yew
South Africa	Pacific Yew
Turkey	Pasifik Porsuğu
Poland	Cis pacyficzny
Sweden	Stillahavs Idegran

Plant Part	*Alkaloids*
Bark	**Paclitaxel (Taxol), 10-Deacetylbaccatin III, Baccatin III, Cephalomannine**
Leaves	**Paclitaxel (Taxol), 10-Deacetylbaccatin III, Baccatin III, Cephalomannine**
Twigs	**Paclitaxel (Taxol), 10-Deacetylbaccatin III, Baccatin III, Cephalomannine**
Needles	**Paclitaxel (Taxol), 10-Deacetylbaccatin III, Baccatin III, Cephalomannine**
Seeds	**Paclitaxel (Taxol), 10-Deacetylbaccatin III, Baccatin III, Cephalomannine**
Roots	**Paclitaxel (Taxol), 10-Deacetylbaccatin III, Baccatin III, Cephalomannine**

Alkaloid	Mechanism of Action	Clinical Uses
Paclitaxel (Taxol)	**Binds to β-tubulin, stabilizes microtubules, and prevents depolymerization, blocking mitosis.**	**Ovarian cancer, breast cancer, non-small cell lung cancer, Kaposi's sarcoma.**
Vinblastine	**Binds to tubulin, inhibits microtubule polymerization, and prevents mitotic spindle formation.**	**Hodgkin's lymphoma, testicular cancer, breast cancer, and other solid tumors.**
Vincristine	**Binds to tubulin, inhibits microtubule formation, and arrests cell division in metaphase.**	**Acute lymphocytic leukemia, Hodgkin's lymphoma, non-Hodgkin's lymphoma.**
Vinorelbine	**Semi-synthetic; disrupts microtubule assembly, blocking mitosis.**	**Non-small cell lung cancer, breast cancer, ovarian cancer.**
Vindesine	**Binds to tubulin, inhibits microtubule formation,**	**Acute lymphocytic leukemia, melanoma,**

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Alkaloid	Mechanism of Action	Clinical Uses
	and prevents cell division.	lung cancer.
Quinine	Inhibits heme polymerase in malaria parasites, leading to toxic heme accumulation.	Treatment and prevention of malaria.
Quinidine	Blocks sodium and potassium ion channels, prolonging the action potential in the heart.	Cardiac arrhythmias (e.g., atrial fibrillation, ventricular tachycardia).
Morphine	Binds to opioid receptors in the CNS, inhibiting pain signals and producing analgesia.	Severe pain management (e.g., post-surgical pain, cancer pain).
Codeine	Metabolized to morphine, binding to opioid receptors to produce mild analgesia.	Mild to moderate pain relief, cough suppression.
Colchicine	Binds to tubulin, inhibits microtubule polymerization, and reduces inflammation.	Gout, familial Mediterranean fever, pericarditis.
Atropine	Blocks muscarinic acetylcholine receptors, inhibiting parasympathetic nervous activity.	Bradycardia, organophosphate poisoning, pre-anesthesia to reduce secretions.
Caffeine	Blocks adenosine receptors, increasing alertness and reducing fatigue.	Stimulant for fatigue, migraines, and enhancing analgesic effects.
Ephedrine	Stimulates α and β-adrenergic receptors, increasing heart rate and blood pressure.	Nasal congestion, hypotension, and asthma (less common now due to side effects).
Nicotine	Binds to nicotinic acetylcholine receptors, stimulating the central and peripheral nervous systems.	Smoking cessation (in the form of nicotine replacement therapy).
Reserpine	Depletes catecholamines and serotonin from nerve terminals, reducing blood pressure.	Hypertension, psychiatric disorders (historically).
Emetine	Inhibits protein synthesis by blocking ribosomal translocation in parasites.	Amoebiasis (historically, now rarely used due to toxicity).
Berberine	Inhibits bacterial and fungal growth, modulates glucose and lipid metabolism.	Diarrhea, diabetes, hyperlipidemia (traditional and investigational uses).
Strychnine	Antagonizes glycine receptors in the CNS, causing excessive neuronal excitation.	Not used clinically; historically as a stimulant (now toxic and banned).
Cocaine	Blocks dopamine, serotonin, and norepinephrine reuptake, causing CNS stimulation.	Local anesthesia (rarely used now due to abuse potential).
Ergotamine	Constricts blood vessels and activates serotonin receptors, reducing migraine symptoms.	Acute migraine attacks.

Scientific Name - ***Camptotheca acuminata***

Local Name – ***Cancer Tree, Happy Tree***

Taxonomic Hierarchy –

- Kingdom: Plantae
- Phylum: Tracheophyta
- Class: Magnoliopsida
- Order: Caryophyllales

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- Family: Cornaceae
- Genus: Camptotheca
- Species: Camptotheca acuminata

Country/Region	Vernacular Name(s)
China	喜树 (Xǐ Shù - "Happy Tree"), 癌症树 (Ái Zhèng Shù - "Cancer Tree")
Tibet	ཤེས་ཤིང་། (Shi Shing - "Happy Tree")
India	Camptotheca (English), कैम्प्टोथेका (Kaimptotheka)
United States	Happy Tree, Cancer Tree
United Kingdom	Happy Tree, Cancer Tree
Germany	Glücksbaum ("Happy Tree"), Krebsbaum ("Cancer Tree")
France	Arbre de la Joie ("Happy Tree"), Arbre Anticancer ("Cancer Tree")
Spain	Árbol de la Felicidad ("Happy Tree"), Árbol Anticáncer ("Cancer Tree")
Italy	Albero della Felicità ("Happy Tree"), Albero Anticancro ("Cancer Tree")
Japan	ハッピーツリー (Happī Tsurī - "Happy Tree"), がんの木 (Gan no Ki - "Cancer Tree")
South Korea	해피 트리 (Haepi Teuri - "Happy Tree"), 암 나무 (Am Namu - "Cancer Tree")
Brazil	Árvore da Felicidade ("Happy Tree"), Árvore Anticâncer ("Cancer Tree")
Mexico	Árbol de la Felicidad ("Happy Tree"), Árbol Anticáncer ("Cancer Tree")
Russia	Дерево Счастья (Derevo Schast'ya - "Happy Tree"), Противораковое Дерево (Protivorakovoye Derevo - "Cancer Tree")
Australia	Happy Tree, Cancer Tree

Active Compound	Mechanism of Action	Clinical Uses
Camptothecin	Inhibits topoisomerase I, causing DNA damage and apoptosis.	Anticancer (ovarian, breast, lung, colorectal cancers).
10-Hydroxycamptothecin	Similar to camptothecin but with enhanced solubility.	Anticancer, antiviral.
9-Methoxycamptothecin	Inhibits topoisomerase I, inducing apoptosis.	Anticancer.

Scientific Name – ***Curcuma longa***
Local Name – ***Turmeric***
Taxonomic Hierarchy –

- **Kingdom**: Plantae
- **Phylum**: Tracheophyta
- **Class**: Liliopsida
- **Order**: Zingiberales

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- **Family**: Zingiberaceae
- **Genus**: Curcuma
- **Species**: Curcuma longa

Country/Region	Vernacular Name(s)
India	हल्दी (Haldi), अर्द्रक (Ardraka)
China	姜黄 (Jiāng Huáng - "Ginger Yellow")
Japan	ウコン (Ukon)
Thailand	ขมิ้น (Khamin)
Indonesia	Kunyit
Malaysia	Kunyit
Spain	Cúrcuma
France	Curcuma
Germany	Kurkuma
Italy	Curcuma
Portugal	Açafrão-da-terra ("Earth Saffron")
Brazil	Açafrão-da-terra, Cúrcuma
Mexico	Cúrcuma
United States	Turmeric
United Kingdom	Turmeric
Middle East	كركم (Kurkum)
Russia	Куркума (Kurkuma)
Africa	Turmeric (English), Dilaw (Swahili)

Active Compound	Mechanism of Action	Clinical Uses
Curcumin	Inhibits NF-κB, COX-2, LOX; modulates STAT3 and PI3K/Akt/mTOR pathways; antioxidant.	Anti-inflammatory, anticancer, antioxidant, neuroprotective, wound healing.
Demethoxycurcumin	Similar to curcumin but with lower potency.	Anti-inflammatory, antioxidant.
Bisdemethoxycurcumin	Similar to curcumin but with lower potency.	Anti-inflammatory, antioxidant.
Turmerone	Anti-inflammatory, neuroprotective.	Neuroprotective, antimicrobial.
Essential Oils	Antimicrobial, antifungal.	Treatment of infections, wound healing.

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Scientific Name - ***Withania somnifera***

Local Name – ***Ashwagandha***

Taxonomic Hierarchy –

- Kingdom Plantae
- Phylum Streptophyta
- Class Equisetopsida
- Subclass Magnoliidae
- Order - Solanales
- Family - *Solanaceae*
- Genus - *Withania*
- Species - *Withania somnifera*

Country/Region	Vernacular Name(s)
India	अश्वगंधा (Ashwagandha), असगंध (Asgandh)
China	睡茄 (Shuì Qié - "Sleep Eggplant")
Japan	アシュワガンダ (Ashwaganda)
Middle East	سمحوق (Samhūq), عين الثور (Ayn al-Thawr - "Eye of the Bull")
United States	Ashwagandha, Indian Ginseng, Winter Cherry
United Kingdom	Ashwagandha, Indian Ginseng
Germany	Ashwagandha, Schlafbeere ("Sleep Berry")
France	Ashwagandha, Ginseng Indien
Spain	Ashwagandha, Ginseng Indio
Italy	Ashwagandha, Ginseng Indiano
Brazil	Ashwagandha, Ginseng Indiano
Mexico	Ashwagandha, Ginseng Indio
Russia	Ашваганда (Ashvaganda), Индийский женьшень (Indiyskiy Zhen'shen')
Africa	Ashwagandha (English), Ubulawu (Zulu)
Nepal	अश्वगन्धा (Ashwagandha)
Sri Lanka	Ashwagandha (Sinhala), Amukkara (Tamil)

Active Compound	Mechanism of Action	Clinical Uses
Withaferin A	Induces apoptosis, inhibits NF-κB, modulates PI3K/Akt/mTOR pathway.	Anticancer, anti-inflammatory, antioxidant.
Withanolide A	Enhances GABAergic activity, stimulates Nrf2 pathway.	Adaptogen, neuroprotective, anxiolytic.
Somniferine	Acts as a mild sedative.	Sleep aid, relaxant.
Tropine	Exhibits anticholinergic effects.	Antispasmodic, gastrointestinal disorders.
Glycowithanolides	Reduces oxidative stress and inflammation in the brain.	Neuroprotective, antioxidant

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Scientific Name – ***Clivia miniata***

Local Name – ***Bush Lily***

Taxonomic Hierarchy -

- Kingdom: Plantae
- Phylum: Tracheophyta
- Class: Magnoliopsida
- Order: Asparagales
- Family: Amaryllidaceae
- Genus: Clivia
- Species: Clivia miniata

Country/Region	Vernacular Name(s)
South Africa	Boslelie (Afrikaans), Umayime (Zulu)
United States	Natal Lily, Bush Lily, Fire Lily
United Kingdom	Natal Lily, Bush Lily
Germany	Clivie, Natal-Lilie
France	Clivia, Lis du Natal
Spain	Clivia, Lirio de Natal
Italy	Clivia, Giglio del Natal
Australia	Natal Lily, Bush Lily
Japan	クリビア (Kuribia)
China	君子兰 (Jūn Zǐ Lán - "Noble Orchid")
India	Clivia (English), नटाल लिली (Natal Lily)
Brazil	Clívia, Lírio-de-Natal
Mexico	Clivia, Lirio de Natal
Russia	Кливия (Kliviya), Натальская лилия (Natal'skaya Liliya)

Active Compound	Mechanism of Action	Clinical Uses
Lycorine	Inhibits protein synthesis, induces apoptosis, antiviral, anti-inflammatory.	Anticancer, antiviral, anti-inflammatory.
Clivatine	Exhibits cytotoxic effects on cancer cells.	Anticancer.
Miniaine	Antioxidant properties.	Antioxidant.

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Scientific Name – ***Andrographis paniculata***
Local Name – ***King of Bitter***
Taxonomic Hierarchy -
Domain: Eukaryota,
Kingdom: Plantae,
Subkingdom: Tracheobionta,
Superdivision: Spermatophyta,
Division: Angiosperma,
Class: Dicotyledonae,
Subclass: Gamopetalae,
Series: Bicarpellatae,
Order: Personales,
Family: Acanthaceae,
Subfamily: Acanthoideae,
Tribe: Justiciae,
Subtribe: Andrographideae,
Genus: *Andrographis*,
Species: *A. paniculata* (Burm. f.)

Language	Name
Arabic	Quasabhuva
Assamese	Chiorta, Kalmegh
Azerbaijani	Acılar Şahı, Acılar Xanı (khanı)
Bengali	Kalmegh
Burmese	Se-ga-gyi
Chinese	Chuan Xin Lian
English	The Creat, King of Bitters
French	Chirette verte, Roi des amers
Gujarati	Kariyatu
Hindi	Kirayat, Kalpanath,
Indonesian	Sambiroto, Sambiloto
Japanese	Senshinren
Kannada	Nelaberu

Konkani	Vhadlem Kiratyem
Lao	La-Sa-Bee
Malay	Hempedu Bumi, Sambiloto
Malayalam	Nelavepu, Kiriyattu
Manipuri	Vubati
Marathi	Oli-kiryata, Kalpa
Mizo	Hnakhapui
Oriya	Bhuinimba
Panjabi	Chooraita
Persian	Nain-e Havandi
Philippines	Aluy, Lekha and Sinta
Russian	Andrografis
Sanskrit	Kalmegha, Bhunimba and Yavatikta
Scandinavian	Green Chiratta
Sinhalese	Hīn Kohomba or Heen Kohomba
Spanish	Andrografis
Tamil	Nilavembu
Telugu	Nilavembu
Thai	Fa-Talai-Jorn, Fah-talai-jon (jone)
Turkish	Acılar Kralı, Acı Paşa, Acı Bey
Urdu	Kalmegh, Kariyat, Mahatita
Vietnamese	Xuyên Tâm Liên
Thai	Fa-Talai-Jorn, Fah-talai-jon (jone)
Turkish	Acılar Kralı, Acı Paşa, Acı Bey
Urdu	Kalmegh, Kariyat, Mahatita
Vietnamese	Xuyên Tâm Liên

Active Compound	Mechanism of Action	Clinical Uses
Andrographolide	Inhibits NF-κB, stimulates Nrf2, induces apoptosis, modulates PI3K/Akt/mTOR pathway.	Antiviral, anti-inflammatory, anticancer, hepatoprotective, immunomodulator.
Neoandrographolide	Anti-inflammatory and hepatoprotective effects.	Anti-inflammatory, hepatoprotective.
Deoxyandrographolide	Antimicrobial and antiviral properties.	Antimicrobial, antiviral.
Flavonoids	Antioxidant and anti-inflammatory effects.	Antioxidant, anti-inflammatory.

3. FUTURE CHALLENGES

Medicinal plants have great promise in treating cancer; however, several obstacles need to be overcome in order to fully exploit their potential. *Standardization and Quality Assurance* :Since the plant composition is variable because of environmental factors, cultivation, and extraction methods, this causes potential obstacle in drug development. *Bioavailability and Pharmacokinetics*: To be effective therapeutics in clinical settings, many plant-derived compounds must overcome challenges related to poor bioavailability , which can restrict the pharmacokinetic properties of these compounds. They require advanced drug delivery systems to improve their absorption and distribution. *Toxicity and Safetylosele rating*: The assumption that natural products are safe is not always true, as many plant chemicals can act as toxins at higher concentrations and with cumulative use. Safety needs to be ensured with rigorous toxicity studies. *Mechanistic Insight*: Many of the plant-based compounds are still poorly understood in their

mechanisms of action, even if they are extraordinarily promising. More studies are required to explain their molecular targets and pathways. Integration and Interdisciplinary Pathways: Beyond research, exploring successful integrations of traditional medicine into modern practices and facilitating interdisciplinary collaboration lies in promoting holistic approaches to health across diverse communities.

4. CONCLUSION

Medicinal plants possess vast potential for the discovery and development of new anticancer agents. Due to their high diversity in phytochemical constituents, these plants exert activity through multiple mechanisms of action and herald a promising future as adjuvants and supplemental agents for cancer treatment. However, converting such knowledge to clinically proven treatments poses a series of scientific, standardization, and bioavailability challenges. This can be remedied by continued partnership between healers, researchers, and clinicians, as supported by the continued funding and encouragement of biotechnological applications and drug delivery systems. This review advocates for additional research and development in the field of plant-based cancer therapy to create more affordable and beneficial alternatives for patients around the world.

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