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PHYTOCHEMICAL SCREENING AND CANCER CELL CYTOTOXICITY OF NEOLAMARCKIA CADAMBA

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ABSTRACT

The Neolamarckia cadamba plant, which has a long history of use in a variety of ethnomedical systems, is the topic of this inquiry on its phytochemical composition and in vitro cytotoxic potential. This plant is considered to be of great medicinal importance. This research aimed to identify phytoconstituents that were bioactive and to evaluate the degree to which these phytoconstituents were able to suppress the proliferation of certain kinds of human cancer cells. In the methanolic, ethanolic, and water-based extracts of the leaves and bark of N. cadamba that were made using the Soxhlet extraction method, a wide range of secondary metabolites were discovered. These metabolites included alkaloids, flavonoids, phenolics, tannins, terpenoids, glycosides, and saponins. Additional research employing cutting-edge techniques like gas chromatography-mass spectrometry (GC-MS) and high-performance thin-layer chromatography (HPTLC) led to the discovery of significant bioactive compounds that have been shown to have pharmacological effects. Through the use of the MTT test on breast cancer (MCF-7), cervical cancer (HeLa), and lung cancer (A549) cell lines, we were able to evaluate the anticancer potential of the plant extracts in vitro. Among the extracts that were tested, the one that was methanolic shown the highest level of cytotoxicity, particularly against MCF-7 cells. This may indicate that it has a role in causing cell death and inhibiting the spread of cancer. These findings provide validity to the ethnomedicinal applications of Neolamarckia cadamba and support the hypothesis that it has the potential to serve as a natural source of anticancer antibiotics. The findings of this study underline the need of conducting further in vivo studies, as well as molecular and mechanistic research, in order to verify the safety and anticancer efficacy of this plant extract for the treatment of cancer.

Keywords: *Neolamarckia cadamba, phytochemical screening, anticancer activity, cytotoxicity, MTT assay, medicinal plants.*

INTRODUCTION

Every year, cancer claims the lives of millions of people, making it a significant challenge for public health officials all over the world. Traditional medicines such as chemotherapy and radiation therapy are two examples of treatments that have made significant progress in recent years, but there is still a significant distance to go in terms of patient safety, cost, and the avoidance of drug resistance. Therefore, there is a heightened interest in discovering novel anticancer medications, particularly those that are created from natural substances, that are both safer and more effective than those that are already available. A significant

number of the anticancer drugs that are now available have their origins in the molecules that are found in medicinal plants. These plants have long been used as a rich source of pharmacologically active compounds. One of the most important initial steps in the process of discovering new cancer therapy leads is the examination of traditional medicinal plants for phytochemicals and the biological evaluation of these plants.

Neolamarckia cadamba (Roxb.) Bosser, a tropical tree that is associated with the Rubiaceae family, is more often referred to as Kadamba. Kadamba is a tree that grows quite quickly. It is indigenous to Southeast Asia and India, and it has been used for a very long time in Ayurvedic and traditional medicine for the treatment of a wide variety of symptoms, such as inflammation, anaemia, liver issues, fever, and other disorders that are quite similar. There is a broad spectrum of biological activity that has been discovered in many plant parts, such as bark, leaves, and flowers. This activity includes antibacterial, antioxidant, hepatoprotective, and wound-healing qualities. The plant contains a wide variety of phytochemicals, including alkaloids, flavonoids, phenolic compounds, glycosides, and saponins, and a significant number of these phytochemicals have been associated with therapeutic effects.

The fact that N. cadamba has both antioxidant and cytotoxic capabilities makes it an appealing candidate for anticancer research. This is because there is growing evidence that oxidative stress and inflammation are linked to the progression of cancer. With the use of human cancer cell lines MCF-7 (breast cancer), HeLa (cervical cancer), and A549 (lung cancer), the purpose of this work is to conduct a comprehensive phytochemical screening of several Neolamarckia cadamba extracts (methanolic, ethanolic, and aqueous) and assess the anticancer efficacy of these extracts in vitro. By integrating traditional knowledge with contemporary scientific methodologies, the purpose of this study is to examine the therapeutic potential of N. cadamba in order to advance the development of plant-based anticancer therapies.

OBJECTIVE

1. To find bioactive components in Neolamarckia cadamba extracts using phytochemical screening and characterisation.

2. To Assess Neolamarckia cadamba extracts' in vitro cytotoxic and anticancer effects on MCF-7, HeLa, and A549 human cancer cell lines.

BACKGROUND AND SIGNIFICANCE OF HERBAL MEDICINE IN CANCER THERAPY

One of the most significant obstacles that the world's public health system is now facing is cancer. In the year 2020, the World Health Organisation (WHO) reported that cancer was responsible for almost 10 million deaths. Furthermore, forecasts indicate that there would be a concerning increase in the incidence and mortality rates of cancer, which may possibly reach 28.4 million new cases by the year 2040. Lung, breast, colorectal, prostate, and stomach cancers are the types of cancer that are diagnosed from time to time the most often. Many patients have seen considerable improvements in their prognosis and survival rates as a result of conventional treatments such as surgery, chemotherapy, radiation therapy, immunotherapy, and targeted therapy. On the other hand, these therapy approaches have limits that are intrinsic to them. Take, for example:

1. It is common for chemotherapy to result in severe adverse effects, including as nausea, inhibition of the immune system, hair loss, and damage to organs.

2. During radiotherapy, the healthy tissues that surround the tumour might be damaged.

3. The problem of drug resistance continues to be a persistent one, particularly with regard to metastatic malignancies.

4. A significant number of patients in low- and middle-income nations are unable to get therapy due to the high expenses involved.

5. As a result of this situation, it is necessary to create alternative or complementary therapy choices that are capable of attacking cancer via numerous pathways, are less toxic, and are cost-effective.

Historical Use of Herbal Medicine in Cancer Care

In the treatment of a wide range of disorders, including cancer, herbal therapy has a long-standing history of use. Ancient medical practices, such as Ayurveda, Traditional Chinese Medicine (TCM), Siddha, Unani, and African ethnomedicine, have been using medicinal plants for the treatment of cancer-like symptoms and tumours for hundreds of years.

Just one example:

1. Ashwagandha, also known as Withania somnifera, and turmeric, also known as Curcuma longa, are two examples of herbs that are used in Ayurvedic medicine due to their rasayana (rejuvenating and anti-cancerous) characteristics.

2. Artemisia annua and Astragalus membranaceus are two examples of herbs that are recognised to have immune modulating and anti-tumor properties in Traditional Chinese Medicine (TCM).

3. These methods have an emphasis on holistic treatment, which involves treating the mind, body, and spirit. They often make use of multi-herbal compositions that function in conjunction with one another.

Contributions of Plant-Derived Compounds to Oncology

The success of modern pharmacology may be attributed, in large part, to natural compounds. A great number of anticancer medications that are now in use are either produced directly from plants or are modelled after chemicals that are found in plants. Important examples include the following: Paclitaxel, also known as Taxol, is a chemical that is extracted from the bark of the Pacific yew tree (Taxus brevifolia). It is used extensively in the treatment of breast and ovarian cancer because it suppresses cell division and promotes the stabilisation of microtubules.

1. Vinblastine and vincristine are two essential components that are used in the treatment of leukaemia and lymphomas. Both of these compounds are derived from Catharanthus roseus, often known as Madagascarperiwinkle.

2. From the plant Camptotheca acuminata, camptothecin is extracted and used as a precursor for the production of topoisomerase inhibitors such as irinotecan and topotecan.

3. Utilised in the treatment of lung and testicular malignancies, etoposide is derived from podophyllotoxin, which is found in Podophyllum peltatum.

4. Because of these accomplishments, the potential of phytochemicals has been verified, and there has been a resurgence of interest in the screening of traditional herbs for those that possess anticancer effects.

Mechanisms of Action of Herbal Medicines in Cancer

The anticancer benefits of herbal medicines are mediated by a wide variety of biological pathways, including the following:

1. Induction of apoptosis: There are several phytochemicals that cause cancer cells to undergo programmed cell death without having any effect on normal cells.

2. Cell cycle arrest: Through the modulation of cell cycle regulators, herbal substances have the ability to put a stop to the uncontrolled growth of tumour cells.

3. Inhibition of angiogenesis: The creation of new blood vessels is inhibited by anti-angiogenic herbs, which results in the tumour being deprived of important nutrients.

4. Suppression of metastasis: There are several herbs that inhibit the invasiveness and migration of cancer cells.

5. Modulation of immune responses: Herbs that modulate the immune system strengthen the body's natural defences, making them better able to identify and eliminate cancer cells.

6. Oxidative stress regulation: Herbs that are high in antioxidants counteract the damage caused by free radicals, which is a factor in the growth of cancer.

As a result of these effects that are directed towards several targets, herbal medications are increasingly being explored for use as adjuvants in integrated cancer therapy.

BOTANICAL PROFILE OF Neolamarckia Cadamba

Taxonomy and Nomenclature

Neolamarckia Cadamba (Roxb.) Bosser, which was formerly known as Anthocephalus cadamba, is a member of the family Rubiaceae, which is well-known for the pharmacologically active members that it contains. Listed below is the taxonomic categorisation of the organisms:

Kingdom: Plantae

Phylum: Angiosperms

Class: Eudicots

Order: Gentianales

Family: Rubiaceae

Genus: Neolamarckia

Species: *Neolamarckia Cadamba (Roxb.) Bosser*

Kadam is the usual name for the plant in Hindi, while Burflower-tree is the name that is often used in English. Other regional names, such as Vellaikadambu in Tamil and Kadamba in Sanskrit, are also used to refer to it throughout this time period.

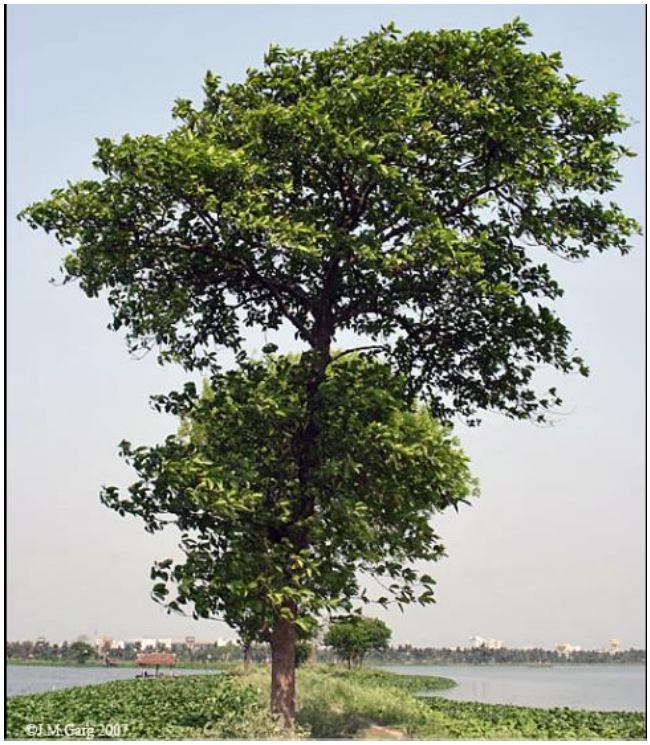

Figure 1 *Neolamarckia Cadamba* (Tree in Kolkata, West Bengal, India)

Figure 2. Close-up of flower (*Neolamarckia Cadamba*)

Figure 3 Various Parts of *Neolamarckia Cadamba*

Botanical Description

In addition to having a straight trunk and a wide, conical crown, the *Neolamarckia Cadamba* is a huge, rapidly growing deciduous tree that may reach heights of 45–50 meters. In younger trees, the bark is smooth and greyish, but as the tree becomes older, it becomes rough.

Leaves: Simple, opposite, large, ovate, and glossy green, measuring 13–32 cm in length.

Flowers: Small, fragrant, orange-yellow, and densely clustered into round, ball-like inflorescences (2–5 cm in diameter).

Fruits: A multiple fruit consisting of numerous small capsules, which are later dispersed by wind and water.

The plant has a quick growth rate, which makes it excellent for plantation forestry. Additionally, it has an ecological function in the management of watersheds and reforestation initiatives.

Geographical Distribution

This species of Neolamarckia Cadamba is indigenous to South and Southeast Asia, and it may be found in a broad range of locations, including:

1. India
2. Nepal
3. Bangladesh
4. Sri Lanka
5. Indonesia
6. Malaysia
7. Philippines
8. Southern China

The tropical and subtropical parts of India are where the tree is most often found. It is especially prevalent in the states of Chhattisgarh, Madhya Pradesh, West Bengal, Assam, Kerala, and Tamil Nadu. The ideal conditions for its development include a warm and humid temperature, well-drained loamy soils, and moist deciduous woods. It thrives in these types of environments.

Traditional and Ethnomedicinal Uses

Within the realm of Indian culture and traditional medical practices, such as Ayurveda and folk medicine, Neolamarckia Cadamba is held in high esteem. Within some cultures, the plant is revered as holy, and it is often grown in close proximity to temples.

When it comes to treating a wide variety of diseases, several components of the plant, including the bark, leaves, flowers, fruits, and roots, have been historically used.

Bark: Astringent, febrifuge, tonic; used for treating fever, pain, ulcers, and inflammation.

Leaves: Applied as poultices for skin diseases, wounds, and swelling.

Fruits: Used for treating digestive problems, including diarrhea and dysentery.

Roots: Used for gum diseases, and to reduce toxicity in traditional detox preparations.

There are numerous references to the Kadamba flower in ancient Indian scriptures and literature. It is especially linked with Lord Krishna, and in some locations, it is honoured during festivals that are named after the Kadamba flower.

Phytochemical Constituents

The investigation of the phytochemical properties of Neolamarckia Cadamba has shown the existence of a wide variety of bioactive chemicals, including the following:

- Alkaloids
- Flavonoids
- Saponins
- Glycosides
- Phenolic compounds
- Tannins
- Steroids
- Terpenoids

Key identified compounds include:

1. Cadambine: An alkaloid with notable pharmacological activity.

2. β-sitosterol, chlorogenic acid, and quinovic acid: Known for anti-inflammatory and antioxidant properties.

3. Lupeol and ursolic acid: Compounds with reported anticancer potential.

It is believed that these phytoconstituents are responsible for the antibacterial, anti-inflammatory, hepatoprotective, antioxidant, antidiabetic, and anticancer effects that have been shown in a number of different research.

Pharmacological and Anticancer Research

Over the course of the last twenty years, Neolamarckia Cadamba has successfully captured the attention of researchers due to the medicinal potential it possesses:

1. Antioxidant activity: Both aqueous and methanolic extracts of the leaves and bark have demonstrated free radical scavenging properties in DPPH and FRAP assays.

2. Anti-inflammatory effects: The plant's extract has been shown to inhibit key inflammatory mediators such as COX-2 and TNF-α in preclinical models.

3. Hepatoprotective activity: Ethanol extracts of the bark have shown liver-protective effects against carbon tetrachloride (CCl_4)-induced toxicity in rats.

4. Antimicrobial properties: Effective against a wide range of gram-positive and gram-negative bacteria.

5. Cytotoxic activity: Preliminary studies using MTT assays on cancer cell lines (e.g., MCF-7, HeLa, A549) suggest moderate in vitro cytotoxicity, warranting further investigation.

Despite the fact that the findings have been encouraging, there is still a lack of complete in vitro and in vivo research, especially in the context of anticancer activity. This has resulted in an urgent need for extensive scientific confirmation.

Industrial and Environmental Applications

Not only is N. cadamba utilised for medical purposes, but it is also used in:

Agroforestry: Its fast growth and broad canopy make it useful for shade, windbreaks, and soil conservation.

Pulp and paper industry: The wood is soft and lightweight, ideal for paper manufacturing.

Timber: Used for plywood, light construction, and furniture making.

As a result of the plant's ability to thrive in places that have been harmed and to improve the fertility of the soil, it also provides a contribution to the reduction of carbon emissions and the restoration of ecological systems. A plant that is remarkable in terms of both its botanical and pharmacological properties is called Neolamarckia Cadamba. It has a long history of traditional use and is acquiring more significance in the scientific community. Its rich phytochemical composition, which, when paired with early pharmacological data, reveals its potential, backs up its promise as a source of novel therapeutic agents, particularly in the area of anticancer drug development. This promise is backed by the fact that it has a rich phytochemical makeup. It would be good to do more research in order to get a better knowledge of its mechanisms of action, to isolate active molecules, and to evaluate its safety and efficacy within the context of a thorough biological evaluation.

CONCLUSION

Neolamarckia cadamba is a historically important medicinal plant, and the findings of this research offer information on the anticancer potential and phytochemical richness of this plant. Alkaloids, flavonoids, phenolics, saponins, and glycosides are some of the substances that have been found as having therapeutic capabilities. These compounds were discovered during the first phytochemical screening. The existence of bioactive compounds that had cytotoxic and antioxidant properties was validated by contemporary analytical techniques such as high-performance thin-layer chromatography and gas chromatography mass spectrometry. The MTT test, which was used for the in vitro cytotoxic evaluation, revealed that the substance exhibited significant anticancer activity. It was the methanolic extract in particular that demonstrated the highest level of inhibition against MCF-7 breast cancer cells." The evidence presented here suggests that N. cadamba may have a role in preventing the proliferation of cancer cells, maybe via the induction of oxidative stress or the death of tumour cells. The results of this study lend validity to the traditional therapeutic use of N. cadamba and demonstrate that it has the potential to serve as a solid starting point for the development of bioactive anticancer medications. It is vital to do more study in order to identify its pharmacological potential in order to ensure that it is both healthy and effective in clinical settings. Bioassay-guided fractionation, the explanation of molecular mechanisms, and in vivo validations should all be included in this study. As a result, this study contributes to the growing body of data suggesting that

traditional medicinal herbs might be used for the creation of modern drugs. Furthermore, it encourages further research into the anticancer benefits of Neolamarckia cadamba.

REFERENCES

[1] Olayemi, O., Isimi, C., Ekere, K., Gbate, M. A., & Emeje, M. (2017). Determination of sun protection factor number: An emerging in vitro tool for predicting UV protection capabilities. International Journal of Herbal Medicine, 5(1), 6–9.

[2] Madan, K., & Nanda, S. (2018). In-vitro evaluation of antioxidant, anti-elastase, anti-collagenase, anti-hyaluronidase activities of safranal and determination of its sun protection factor in skin photoaging. Bioorganic Chemistry, 77, 159–167.

[3] Nunes, A. R., Rodrigues, A. L., de Queiróz, D. B., Vieira, I. G., Neto, J. F., Junior, J. T., Tintino, S. R., de Morais, S. M., & Coutinho, H. D. (2018). Photoprotective potential of medicinal plants from Cerrado biome (Brazil) in relation to phenolic content and antioxidant activity. Journal of Photochemistry and Photobiology B: Biology, 189, 119–123.

[4] Yaseen, M., Mahmood, T., Yousaf, A. M., Shahzad, Y., Bjørklund, G., & Lysiuk, R. (2018). Formulation, characterization and in-vitro sun protection factor of a lemongrass sunscreen lotion. Proceedings of the Pakistan Academy of Sciences: B. Life and Environmental Sciences, 55(2), 11–20.

[5] Pratama, G., Yanuarti, R., Ilhamdy, A. F., & Suhana, M. P. (2019). Formulation of sunscreen cream from Eucheuma cottonii and Kaempferia galanga (Zingiberaceae). IOP Conference Series: Earth and Environmental Science, 278(1), 012062.

[6] Naik, S. N., & Desai, S. (2019). Estimation and comparison of hydro-alcoholic and water extract for sun protection factor activity from naturally available resources. International Journal of Environmental Sciences & Natural Resources, 21(1), 15–20.

[7] De Silva, D. S. N. (2019). Investigation of sun screening and antioxidant activity of M. indica ver "Willard". Journal of Pharmacognosy and Phytochemistry, 8(4), 1130–1133.

[8] Priani, S. E., Mela, K. A., & Lukmayani, Y. (2017). Development of sunscreen microemulsion gel containing n-hexane fraction of mangosteen pericarp (Garcinia mangostana Linn.). Research Journal of Pharmacy, Biology and Chemical Sciences, 8(1S), 229.

[9] Aloanis, A. A., Karundeng, M., Paat, V. I., Tengker, S. M., & Siwu, O. (2021). Sun protecting factor value of the Ficus benjamina Linn. fruits extract. Journal of Physics: Conference Series, 1968(1), 012009.

[10] Gharge, V., Lokhande, T., & Hadpad, S. (2018). Anti-solar study of ethanolic extract of leaves Cassia fistula. Journal of Drug Delivery and Therapeutics, 8(5-s), 232–234.

[11] Buddepu, M., Sabithadevi, K., Ashok, V., & Ramprasad, M. V. (2011). Determination of in-vitro sunscreen activity of Pongamia pinnata (L.) essential oil. Drug Invention Today, 3(8).

[12] Indrayani, A. W., Artini, I. G., Widhiarthini, I. A., Tianing, N. W., & Jawi, I. M. (2020). The potential of sunscreen preparation containing ethanol extract of Moringa oleifera leaves in nanoemulgel formulation. Bali Medical Journal, 9(3), 893–902.

[13] Kapur, A. N., Sati, S. A., Ranjan, A. S., & Gupta, P. R. (2012). Screening methanolic extracts of Beta vulgaris roots for photoprotective activity. International Journal of Pharmacy and Pharmaceutical Sciences, 4(4), 124–127.

[14] Priyanka, S., Mary, S. R., Nandini, H. S., Kutty, A. V., & Kiranmayee, P. (2018). A pilot study on sun protection factor of plant extracts: An observational study. Asian Journal of Pharmaceutical and Clinical Research, 11, 67–71.

[15] Sharma, T., Tyagi, V., & Bansal, M. (2020). Determination of sun protection factor of vegetable and fruit extracts using UV–Visible spectroscopy: A green approach. Sustainable Chemistry and Pharmacy, 18, 100347.

[16] Kapil, A., Koul, I. B., & Suri, O. P. (1995). Antihepatotoxic effects of chlorogenic acid from Anthocephalus cadamba. Phytotherapy Research, 9(3), 189–193.

[17] Chandrashekar, K. S., Prasanna, K. S., & Abinash, B. (2010). Anti-inflammatory effect of the methanol extract from Anthocephalus cadamba stem bark in animal models. International Journal of Plant Biology, 1(1), e6.

[18] Acharyya, S., Dash, G. K., Mondal, S., & Dash, S. K. (2011). Antioxidant effect of methanol extract from Anthocephalus cadamba (Roxb.) Miq. roots. Biomed, 5(2), 132–139.

[19] Nagakannan, P., Shivasharan, B. D., Veerapur, V. P., & Thippeswamy, B. S. (2011). Sedative and antiepileptic effects of Anthocephalus cadamba Roxb. in mice and rats. Indian Journal of Pharmacology, 43(6), 699.

[20] Alam, M. A., Subhan, N., Chowdhury, S. A., Awal, M. A., Mostofa, M., Rashid, M. A., Hasan, C. M., Nahar, L., & Sarker, S. D. (2011). Anthocephalus cadamba (Roxb.) Miq., Rubiaceae, extract shows hypoglycemic effect and eases oxidative stress in alloxan-induced diabetic rats. Revista Brasileira de Farmacognosia, 21, 155–164.