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Ethnomedicinal and pharmacological perspectives on *Alocasia cucullata*: potential in cancer and immune modulation- A review

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ABSTRACT

Alocasia cucullata (Lour.) G. Don, commonly known as Chinese taro or Buddha's hand, is a fast-growing herbaceous plant in the Araceae family, renowned for its large, glossy leaves and often referred to as "Elephant's ear." Widely recognized in traditional Chinese medicine, it is valued for its detoxifying, anti-inflammatory, and wound-healing properties. Recent pharmacological studies have revealed its significant anticancer potential, particularly against melanoma, gastric cancer, and breast cancer. The 50% ethanol extract (EAC) of *A. cucullata* exhibits strong antiproliferative effects against cancer cell lines such as B16-F10, A375, A2058 (melanoma), MGC-803 (gastric cancer), and SiHa (cervical cancer). Further analysis of the petroleum ether extract (EAC-PE) identified 43 bioactive compounds, while the n-BuOH fraction (EAC-B) induced cell cycle arrest and apoptosis, confirming its anticancer efficacy. Ten steroids and iridoids were isolated from *A. cucullata* tubers, including new compounds alocasgenin A and alocasgenoside B-C, alongside known compounds like tenacigenin B and marsdenoside A-B. These compounds demonstrated significant cytotoxic activity against MGC-803 and HT-29 tumor cell lines, with some exhibiting tyrosine kinase inhibition. Additionally, a water-soluble polysaccharide, ACP-1, isolated from the roots, showed immunostimulatory effects by enhancing RAW264.7 cell proliferation, phagocytosis, and cytokine secretion via the NF-κB pathway. Despite its therapeutic potential, *A. cucullata* remains understudied, necessitating further research to validate its traditional uses and explore its mechanisms of action. Its multifaceted bioactive properties position it as a promising candidate for modern therapeutic development, particularly in cancer treatment and immunomodulation. Bridging traditional knowledge with scientific investigation could unlock its full potential as a natural remedy.

Keywords: *Alocasia cucullata, Anti-inflammatory, Wound-healing, Anticancer.*

1. INTRODUCTION

Alocasia cucullata (Lour.) G. Don (Fig.1), commonly known as Chinese taro or Buddha's hand, is a fast-growing herbaceous plant in the Araceae family. Known for its large, glossy, and strikingly beautiful leaves, it is often called "Elephant's ear," a name commonly used for several species within the Alocasia genus. This plant is admired for its simple yet tranquil beauty, characterized by its glossy, heart-shaped leaves that add a touch of elegance to any space. Often kept in temples across Laos and Thailand, *Alocasia cucullata* is believed to bring good luck, making it a cherished plant in cultural and spiritual practices. The plant thrives in bright light to partial shade, making it adaptable to various indoor and outdoor environments. Its lush foliage and easy-care nature have made it a popular choice for both ornamental and symbolic purposes. Whether used as a decorative houseplant or a meaningful addition to sacred spaces, *A. cucullata* is a versatile and visually appealing species that continues to captivate plant enthusiasts and cultural traditions alike. It is widely distributed across South China and other

tropical and subtropical regions of Asia. Beyond its ornamental appeal, *A. cucullata* holds significant ethnomedicinal value, particularly in traditional Chinese medicine (TCM). The tuber of the plant, known as "jianweiyu" in Chinese, is highly prized for its therapeutic properties and has been used for centuries by the Zhuang ethnic group in China to reduce swelling, detoxify the body, and alleviate pain. This dual role as both an ornamental and medicinal plant underscores its cultural and practical importance [1-3].

2. MATERIALS AND METHODS

Multiple literature searches on the ethnomedicinal uses, botany, chemical composition, and pharmacological properties of Alocasia cucullata were conducted. Relevant information was obtained from online databases such as PubMed, Google Scholar, Scopus, and Science Direct. Additional sources, including journal articles, and books, were accessed through the university library. The search included keywords such as "*Alocasia cucullata*", its synonyms, and common names, along with terms related to its biological and medicinal properties.

Ethnomedicinal uses

In traditional medicine systems, particularly in China and Southeast Asia, *A. cucullata* has been utilized to treat a wide range of ailments. Among the Zhuang people, the tuber is often prepared as a medicinal drink to clear excessive heat from the body, a concept central to TCM that associates heat with inflammation and toxicity. This preparation is also used to reduce swelling and relieve pain, making it a versatile remedy for conditions such as arthritis, rheumatism, and other inflammatory disorders [4,5]. The plant's cooling and detoxifying effects are believed to restore balance to the body's internal systems, aligning with the principles of TCM.

In addition to its internal applications, *A. cucullata* is also used externally to treat various skin conditions. Its anti-inflammatory and wound-healing properties make it effective in managing ailments such as abscesses, eczema, and other dermatological issues [6]. The tubers, leaves, and stems of the plant are often crushed or processed into poultices or ointments and applied topically to reduce inflammation, promote healing, and prevent infections. This dual use both internally and externally demonstrates the plant's versatility and its integral role in traditional healing practices. The widespread use of *A. cucullata* in traditional medicine highlights its therapeutic potential, which is deeply rooted in cultural practices and historical knowledge. However, despite its ethnomedicinal significance, the plant remains understudied in modern scientific research. Further investigation is needed to validate its traditional uses, identify its bioactive compounds, and explore its potential for modern therapeutic applications. By bridging the gap between traditional knowledge and contemporary science, *A. cucullata* could emerge as a valuable resource for the development of natural-based treatments for inflammation, pain, and skin disorders [7].

Beyond its applications in China, *A. cucullata* has also been used in other parts of Southeast Asia to address conditions such as rheumatism, joint pain, and musculoskeletal disorders. Its anti-inflammatory properties are particularly valued in these contexts, where it is often incorporated into traditional remedies to relieve pain and improve mobility [8]. Furthermore, the plant has been employed in some regions to treat digestive issues and respiratory ailments, though these uses are less documented and warrant further exploration. Despite its widespread use in traditional medicine, *A. cucullata* remains understudied in modern scientific research. While its ethnomedicinal applications provide a strong foundation for its therapeutic potential, there is a pressing need for systematic studies to validate these traditional uses and elucidate the underlying mechanisms of action. For instance, the plant's anti-inflammatory, detoxifying, and wound-healing properties could be linked to its bioactive compounds, such as flavonoids, alkaloids, and steroids, which are known to possess medicinal properties. Investigating these compounds could unlock new avenues for drug discovery and development.

Moreover, the integration of traditional knowledge with contemporary scientific approaches could enhance the understanding of *A. cucullata* therapeutic potential. *A. cucullata* represents a valuable resource in traditional medicine, with a wide range of applications rooted in centuries of cultural practice. Its use as a detoxifying agent, anti-inflammatory remedy, and wound-healing treatment underscores its therapeutic versatility. However, the limited scientific research on this plant highlights the need for further investigation to validate its traditional uses and explore its potential for modern therapeutic development. By bridging the gap between traditional knowledge and contemporary science, *Alocasia cucullata* could emerge as a promising candidate for the development of novel, natural-based treatments for a variety of health conditions [9-12].

Botanical description

Alocasia cucullata (Lour.) G. Don, commonly known as Chinese taro or Elephant's ear, is a small to medium-sized, evergreen, clumping herb that belongs to the Araceae family. This perennial plant grows up to 1 meter in height and is characterized by its robust, fleshy stems that are basally branched and hypogeal (underground). The plant produces numerous large, heart-shaped leaves with broadly ovate cordate blades measuring 10–40 cm in length and 7–28 cm in width. The leaves grow on long, sheathed petioles that are weakly D-shaped in cross-section and can reach up to 80 cm in length. Each leaf has four primary veins radiating from the petiole, arching toward the margins, while secondary veins are less prominent. Inflorescences are rare but, when produced, are solitary or occasionally paired, emerging from the leaf bases on peduncles 20–30 cm long. The inflorescence consists of a green spathe enclosing a spadix, which is divided into distinct zones: a

cylindrical female zone (1.5–2.5 cm long), a sterile zone (2–3 cm long), a yellow male zone (3.4 cm long), and a narrowly conical appendix (3.5 cm long). Fruiting is uncommon, but when it occurs, the plant produces subglobose berries that ripen to a bright red color, measuring 6–8 mm in diameter [13,14].

Geographical distribution

Native to tropical and subtropical regions of Asia, *Alocasia cucullata* is widely distributed across South China, Southeast Asia (including Myanmar, Thailand, Laos, Vietnam, and Taiwan), and South Asia (such as Bangladesh, Sri Lanka, and the Himalayan regions). It has also been cultivated and naturalized in other parts of the world, including Japan, Singapore, Malaysia, Costa Rica, Honduras, Cuba, Colombia, Ecuador, and various Pacific islands. The plant thrives in warm, humid climates and is often grown as an ornamental species due to its striking foliage. Additionally, it holds significant ethnomedicinal value, particularly in traditional Chinese medicine, where its tuber is used for detoxification, reducing swelling, and alleviating pain. Its adaptability and dual role as both an ornamental and medicinal plant make *Alocasia cucullata* a notable species within the *Alocasia* genus [15].

Figure 1. Alocasia cucullata

Phytochemistry of *A. cucullata*

In a study on *A. cucullata*, ten steroids and iridoids were isolated from its tubers, including two new compounds, alocasgenin A (1) and alocasgenoside B-C (2-3), along with alocasgenol (1a), the aglycone of compound 1 obtained through acid hydrolysis. Additionally, tenacigenin B (4), 17β-tenacigenin B (5), 3-O-6-deoxy-3-O-methyl-β-D-allopyranosyl-(1→4)-β-D-oleandropyranosyl-tenacigenin C (6), marsdenoside A-B (7-8), and tenacigenoside A-B (9-10) were identified for the first time in the Alocasia genus. The chemical structures of these compounds were determined through extensive spectral analysis and comparison with existing literature. Cytotoxic and tyrosine kinase inhibition assays revealed that compounds 1-10, 1a, and compound 2 exhibited significant growth inhibition against MGC-803 and HT-29 tumor cell lines, while compounds 1, 1a, 3, 6, and 8 showed moderate inhibitory activity. Notably, compound 2 demonstrated biochemical inhibition of enzyme activity, highlighting its potential as a therapeutic agent [16]. In another study, a water-soluble polysaccharide, ACP-1, was isolated from the roots of Alocasia cucullata using freeze-thaw treatment (FTT). Structural analysis revealed ACP-1 to be a homogeneous heteropolysaccharide with a molecular weight of 2.10 × 10^5 Da, primarily composed of glucose, galactose, and arabinose, with traces of fucose, rhamnose, and glucuronic acid. Methylation and nuclear magnetic resonance (NMR) spectroscopy indicated that the backbone of ACP-1 consisted of →[3)-β-D-Galp-(1]4→3,6)-β-D-Glcp-(1→3,6)-β-D-Glcp-(1→, with a branch at C-3. In vitro experiments demonstrated that ACP-1 significantly enhanced the proliferation and phagocytosis of RAW264.7 cells, upregulated the expression of co-stimulatory molecules (CD80 and CD86), and activated RAW264.7 cells via the nuclear factor kappa-B (NF-κB) signaling pathway. This activation led to the release of nitric oxide and the secretion of cytokines such as tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), and interleukin-6 (IL-6). These findings suggest that ACP-1 has potential as a novel immunostimulant, offering new avenues for immune-related therapeutic applications. These studies underscore the pharmacological potential of Alocasia cucullata, with its bioactive compounds demonstrating significant anticancer and immunomodulatory properties. Further research is needed to fully explore its therapeutic applications and mechanisms of action [17].

Antiproliferative Effects of *A. cucullata*

The antiproliferative effects of *A. cucullata* are among its most well-documented anticancer properties. Cancer cell proliferation is a hallmark of malignancy, and inhibiting this process is a key strategy in cancer treatment. The 50% ethanol extract of *A. cucullata* has been extensively studied for its ability to suppress the growth of various cancer cell lines, including

melanoma, gastric cancer, and cervical cancer. Below, we explore the antiproliferative effects of *A. cucullata* in detail, focusing on its mechanisms of action and its potential as a natural therapeutic agent [18].

Melanoma

Melanoma is one of the most aggressive forms of skin cancer, characterized by rapid proliferation, high metastatic potential, and resistance to conventional therapies. The antiproliferative effects of *A. cucullata* have been particularly promising in melanoma treatment. *A. cucullata* has demonstrated strong antiproliferative activity against melanoma cell lines such as B16-F10, A375, and A2058. These cell lines are widely used in cancer research due to their aggressive growth and resistance to treatment. *A. cucullata* significantly reduced the viability of melanoma cells in a dose-dependent manner. Higher concentrations of the extract led to greater inhibition of cell proliferation, indicating its potent anticancer activity. The antiproliferative effects of EAC in melanoma are attributed to its ability to induce cell cycle arrest and apoptosis. The extract disrupts the cell cycle, preventing cancer cells from progressing through the phases necessary for division. Additionally, *A. cucullata* activates apoptotic pathways, leading to programmed cell death [19,20]. The ability of *A. cucullata* to inhibit the proliferation of melanoma cells, even in resistant cell lines, highlights its potential as a natural therapeutic agent. Further research could explore its use in combination with existing therapies to enhance treatment outcomes.

Gastric Cancer

Gastric cancer is one of the most common malignancies worldwide, with a high mortality rate due to late diagnosis and limited treatment options. The antiproliferative effects of *A. cucullata* on gastric cancer cells offer a promising avenue for developing alternative therapies. *A. cucullata* has been tested on the MGC-803 gastric cancer cell line, which is derived from human gastric adenocarcinoma. This cell line is widely used to study the mechanisms of gastric cancer and evaluate potential treatments [20]. *A. cucullata* exhibited significant inhibition of MGC-803 cell proliferation. The extract reduced cell viability and suppressed the growth of gastric cancer cells in a dose-dependent manner [20]. The antiproliferative effects of *A. cucullata* in gastric cancer are linked to its ability to modulate key signaling pathways, such as the PTEN/PI3K/AKT pathway. By upregulating PTEN and inhibiting the phosphorylation of PI3K and AKT, *A. cucullata* disrupts the signaling cascade that promotes cancer cell survival and proliferation [5]. The antiproliferative effects of *A. cucullata* on MGC-803 cells suggest that it could be developed into a natural therapeutic agent for gastric cancer. Its ability to target specific signaling pathways also makes it a potential candidate for combination therapies.

Cervical Cancer

Cervical cancer is a major health concern, particularly in developing countries where access to screening and treatment is limited. The antiproliferative effects of *A. cucullata* on cervical cancer cells offer hope for new treatment options. *A. cucullata* has been tested on the SiHa cervical cancer cell line, which is associated with human papillomavirus (HPV) infection. HPV is a major risk factor for cervical cancer, and the SiHa cell line is commonly used to study HPV-related malignancies [20]. The SiHa cell line was found to be highly sensitive to *A. cucullata* treatment. The extract significantly reduced cell viability and inhibited the proliferation of cervical cancer cells in a dose-dependent manner [20]. The antiproliferative effects of *A. cucullata* in cervical cancer are likely mediated by its ability to induce apoptosis and cell cycle arrest. The extract activates caspase enzymes, which are essential for apoptosis, and disrupts the cell cycle, preventing cancer cells from dividing [21]. The antiproliferative effects of *A. cucullata* on SiHa cells suggest that it could be developed into an affordable and accessible treatment option for cervical cancer. Its ability to target HPV-related malignancies is particularly noteworthy, as HPV is responsible for the majority of cervical cancer cases.

The antiproliferative effects of *A. cucullata* are a cornerstone of its anticancer properties. The 50% ethanol extract *A. cucullata* has demonstrated potent activity against melanoma, gastric cancer, and cervical cancer cell lines, significantly reducing cell viability and inhibiting proliferation. These effects are mediated by multiple mechanisms, including cell cycle arrest, apoptosis induction, and modulation of key signaling pathways. The ability of *A. cucullata* to target aggressive and resistant cancer cell lines highlights its potential as a natural therapeutic agent. Further research is needed to optimize its extraction, formulation, and delivery, as well as to evaluate its safety and efficacy in clinical trials. With its multifaceted antiproliferative effects, *A. cucullata* holds great promise as a complementary or alternative therapy for various types of cancer.

Immunomodulatory Effects of *A. cucullata*

The immunomodulatory effects of *A. cucullata* represent a significant aspect of its anticancer properties. While its direct cytotoxic effects, such as antiproliferation and apoptosis induction, are well-documented, its ability to modulate the immune system adds another layer of therapeutic potential. The immune system plays a critical role in cancer surveillance and elimination, and enhancing its function can significantly improve cancer treatment outcomes. *A. cucullata* has been shown to stimulate immune responses against tumours, making it a promising candidate for immunotherapeutic applications. Below, we delve into the details of its immunomodulatory effects, focusing on cytokine release and immune system activation.

Cytokines are small proteins that play a crucial role in cell signaling within the immune system. They regulate immune responses by promoting or inhibiting inflammation, activating immune cells, and facilitating communication between cells.

A. cucullata has been shown to stimulate the release of antitumor cytokines, which enhance the immune system's ability to recognize and eliminate cancer cells. IL-2 is a cytokine that plays a central role in the proliferation and activation of T cells, which are essential for adaptive immunity. T cells are responsible for recognizing and destroying cancer cells. In a mouse tumor model, the water extract of *A. cucullata* was found to increase IL-2 levels. This increase correlated with enhanced T cell activity and improved antitumor responses [22]. By stimulating IL-2 production, *A. cucullata* helps amplify the immune system's ability to target and eliminate cancer cells. Interferon gamma (IFN-γ) is a cytokine produced primarily by natural killer (NK) cells and T cells. It has potent antitumor effects, including the activation of macrophages, enhancement of antigen presentation, and direct inhibition of tumor cell proliferation. Studies have shown that *A. cucullata* extract increases IFN-γ levels in tumor-bearing mice. This cytokine not only enhances the immune response but also creates an unfavourable microenvironment for tumor growth by promoting inflammation and immune cell infiltration [22]. The upregulation of IFN-γ is particularly significant because it bridges innate and adaptive immunity, making it a key player in cancer immunosurveillance. Tumor necrosis factor-alpha (TNF-α) is a pro-inflammatory cytokine that induces apoptosis in cancer cells and inhibits tumor angiogenesis (the formation of new blood vessels that supply tumours).The water extract of *A. cucullata* has been shown to stimulate TNF-α production in mouse models. This cytokine contributes to the direct killing of cancer cells and the suppression of tumor growth. TNF-α also enhances the activity of other immune cells, such as macrophages and dendritic cells, further amplifying the antitumor immune response. In a mouse tumor model, the water extract of *A. cucullata* increased the median survival time by 16 days compared to the control group. This remarkable improvement in survival was directly linked to the enhanced cytokine release and subsequent immune activation [22].

3. CONCLUSION

A. cucullata exhibits remarkable pharmacological potential, particularly in cancer treatment and immunomodulation. Its bioactive compounds, including steroids, iridoids, and polysaccharides, have demonstrated significant cytotoxic, antiproliferative, and immunostimulatory effects. The plant's traditional medicinal applications align with emerging scientific findings, highlighting its therapeutic relevance. However, further research is essential to elucidate its mechanisms of action, optimize its medicinal applications, and ensure its safety and efficacy. Integrating traditional knowledge with modern pharmacological studies could pave the way for its development as a novel therapeutic agent.

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5. AUTHOR CONTRIBUTIONS

All authors made substantial contributions to the conception, design, data acquisition, analysis, and interpretation; participated in drafting or critically revising the manuscript for important intellectual content; approved the final version for submission; and agrees to be accountable for all aspects of the work. The author meets the authorship criteria as per ICMJE guidelines and declares no financial or other conflicts of interest.

CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ETHICAL APPROVALS

As this review is based on previously published literature, ethical approval and informed consent were not required.

DATA AVAILABILITY

This overview of *Alocasia cucullata* is based on publicly accessible information and data cited in the references.

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