

The Role of Ayurvedic Botanicals in Cancer Care: An Integrative Approach.

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ABSTRACT

Cancer residues a foremost global health challenge, accounting for approximately 19.4 million new cases and 10 million deaths annually. Conventional treatment modalities, though effective, are often limited by issues such as convenience, high costs, and significant adverse effects. The vast pharmacopeia of Ayurveda offers promising alternatives, presenting anticancer, immunomodulatory, and palliative properties. Ayurvedic medicinal plants have served as a prolific source of bioactive leads for drug discovery, with several novel compounds presently under clinical evaluation. Widespread research has documented the therapeutic potential of numerous Ayurvedic herbs and their residents in cancer management. This includes key botanicals such as Triphala, Guduchi, Pippali, Ashwagandha, Turmeric, Bhallathaka, and Varuna, each investigated for their active compounds, mechanisms of action, and supporting clinical evidence. There is a growing interest in integrative approaches that combine Ayurvedic botanicals with conventional cancer therapies to improve efficacy and minimize side effects. Experiments related to standardization, quality control, and clinical validation remain critical, alongside emerging research directions encircling advanced extraction techniques, innovative drug delivery systems, and genetic-level interventions. Overall, this comprehensive review underscores the therapeutic potential and scientific rigor necessary to establish Ayurvedic medicinal plants as valuable components within the global oncology landscape, offering accessible, affordable, and holistic treatment possibilities. Prominently, Ayurvedic practices are intended as complementary strategies-supporting cancer prevention, reducing health risks, strengthening the body, and promoting immune recovery post-treatment-rather than replacing modern oncological therapies. This review examines recent progress in integrative oncology, emphasizing the role of Ayurvedic medicinal plants in cancer treatment and supportive care. It consolidates evidence on the phytochemical profiles, biological effects, cellular mechanisms, and therapeutic potential of various Ayurvedic herbs used in cancer management.

Keywords: Anti-cancer agents, apoptosis, cancer, medicinal plants, phytochemicals

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1. INTRODUCTION

Cancer remnants one of the leading causes of morbidity and mortality worldwide. It is the second most common cause of death among non-communicable diseases, surpassed only by cardiovascular disorders. Once considered a dreaded disease of the 20th century, cancer continues to rise in pervasiveness in the 21st century. Frightening statistics disclose that one in four individuals faces a lifetime risk of evolving cancer. Globally, over 14 million new cases are reported annually, with India contributing more than 1.1 million new diagnoses each year ^[1]. Over latest decades, cancer therapy has advanced remarkably, and conventional treatments have suggestively improved survival rates and quality of life. The principal treatment modalities include surgery, chemotherapy, radiotherapy, immunotherapy, targeted therapy, and hormone therapy. Each of these approaches offers distinct advantages and limitations, and therapeutic plans are typically modified based on cancer type, stage, and the patient's overall condition. Despite their progress, conventional treatments are often associated with substantial side effects, restricted efficacy, and risks of recurrence. These challenges have stimulated growing interest in alternative and complementary medicine systems, predominantly those derived from natural sources. Medicinal plants, long used for their anti-inflammatory, anticancer, and immunomodulatory properties, present hopeful avenues for.

integrative oncology. By merging traditional Ayurvedic wisdom with modern scientific research, these botanical therapies may enhance therapeutic outcomes and improve patient well-being [2]. This review explores current advancements in integrative oncology with a focus on the contributions of Ayurvedic medicinal plants to cancer therapy and supportive care. It synthesizes findings on the phytochemical composition, biological activities, cellular mechanisms, and therapeutic applications of several Ayurvedic herbs relevant to cancer management. It highlights the impact of sedentary lifestyles as a cancer risk factor and discusses Ayurvedic strategies for prevention through anti-inflammatory modulation, enhancement of detoxification pathways, regulation of gut microbiota, and stress reduction. The analysis stresses the necessity of integrative approaches in modern public health frameworks by aligning traditional knowledge with contemporary biomedical evidence. Although modern science has made remarkable progress in understanding the molecular underpinnings of cancer, gaps persist in its prevention and holistic management. Predictable monotherapies targeting single signaling pathways often yield limited results, whereas multi-targeted strategies, characteristic of Ayurvedic formulations, may offer superior therapeutic potential. Modern medicine, though evidence-based, relies predominantly on single-compound drugs—an approach that is relatively recent in human history. In contrast, traditional medical systems such as Ayurveda have evolved over millennia, offering a multidimensional understanding of health and disease [3]. This review emphasizes the enduring relevance of traditional medicine in the modern era and advocates for its thoughtful integration with contemporary scientific practice. It particularly focuses on Ayurvedic approaches to cancer prevention and treatment, emphasizing their role in addressing inflammation and enhancing resilience through holistic, evidence-informed methodologies.

2. AYURVEDA CONCEPT OF TREATMENT OF CANCER

The Ayurvedic therapeutic outline for cancer management encompasses multiple modalities, including *prakritistani chikitsa* (maintenance of health), *rasayana chikitsa* (restoration and rejuvenation), *naishthiki chikitsa* (spiritual therapy), and *roghanashani chikitsa* (disease eradication) [4]. Treatment assortment follows a meticulous evaluation of the patient's constitution, disease stage, and strength, ensuring an adapted approach. Paramount position is accorded to patient safety, emphasizing strict aseptic systems during surgical procedures such as thorough sterilization of instruments and adherence to hygienic practices. Therapeutic policies contain surgical excision of tumors, administration of herbal formulations, dietary modifications, and a spectrum of spiritual and holistic therapies, such as detoxification, rejuvenation, prayer, music therapy, aromatherapy, gem therapy, sound therapy, stress reduction, meditation, yoga, and astrology-based guidance. Amongst the principal modalities, *shodhana chikitsa* (purificatory therapy) is extensively employed to eliminate aggravated doshas and restore internal balance [5]. Both internal and external purification were achieved through the five classical procedures of *panchakarma chikitsa* namely *vamana* (therapeutic emesis), *virechana* (purgation), *basti* (medicated enema), *nasya* (nasal administration), and *rakta mokshana* (bloodletting). The purification process begins with *snehana* (oleation), wherein medicated oils are applied externally or administered internally. The composition of the oil varies according to the dominant dosha-kaphaghna agents for kapha imbalance and pittaghna agents for pitta predominance [6].

Therapeutic interventions are dosha-specific: emesis for excess kapha, purgation for pitta, and enema for vata imbalance. Cytotoxic chemotherapy, radiation therapy, and surgical excision in modern oncology parallel *shodhana* approaches by primarily reducing kapha dominance and purging diseased tissues. *Shamana chikitsa* (palliative therapy) is employed to gradually pacify the aggravated doshas and alleviate symptoms, particularly in patients too weak to undergo *shodhana* procedures. Preservation of vitality and endurance remains a key therapeutic objective. Ayurveda also advocates *rasayana chikitsa*, aimed at immunomodulation and systemic rejuvenation. Adaptogenic and antioxidant herbs such as *amalaki* (*Emblica officinalis*), *guduchi* (*Tinospora cordifolia*), *pippali* (*Piper longum*), *ashwagandha* (*Withania somnifera*), *chyavanprash*, and *Brahma rasayana* are utilized to enhance immunity and cellular resilience [7]. *Rasayana* therapies restore physiological balance, counteracting the debilitation caused by purificatory treatments and preparing the body for dosha-specific interventions.

Emotional and psychological healing is also integral to Ayurvedic oncology. Psychotherapy, yoga, meditation, prayer, chanting, and sound therapy are incorporated to reduce stress, promote mental stability, and facilitate cellular detoxification. Astrological analysis may be conducted to assess planetary influences, with corresponding remedial measures such as mantras, rituals, or gem prescriptions. Exercise and diet are considered essential adjuncts to therapy. However, intense physical activity is discouraged for frail or undernourished individuals. But, gentle yoga postures are prescribed to enhance organ function, improve glandular activity, and strengthen immunity without exerting undue strain [8]. Dietary recommendations are individualized, taking into account the patient's age, constitution (*prakriti*), season, environment, and socioeconomic context. Historically, during the era of Atreya and Dhanvantari (7th century BCE), surgery was recognized as one of the most effective treatments for *arbuda* (tumors). Early Ayurvedic texts describe successful treatments of *granthi* (glandular swellings) and *gulma* (cystic or solid tumors) through a combination of surgical and herbal measures. Surgical interventions included incision, excision, puncture, curettage, scarification, and suturing, followed by cauterization using alkalis or thermal methods to prevent recurrence and meticulous postoperative care to promote wound healing. Exemplary attention was paid to sterility, with practitioners instructed to avoid residual tumor tissue to prevent recurrence or metastasis—an insight vividly illustrated by the analogy that even a small remaining ember

can rekindle a great fire. In the ama (immature) stage of granthi, treatment approaches paralleled those for sophia (inflammation), involving swedana (fomentation), upanaha (poultices), and lepa (medicated pastes) tailored to the aggravated dosha [9]. Once the tumor matured, it was incised, drained, irrigated with herbal decoctions, purified, and finally cauterized. Medicated oils were then applied to promote healing. The advent of rasa shastra (the alchemical science of metals and minerals, particularly mercury and arsenic) between 600 and 1200 CE, under the Siddha tradition, revolutionized Ayurvedic oncology. Practitioners came to believe that many malignancies were curable-especially when treated in their early stages-by employing carefully processed metallic and mineral preparations in conjunction with herbal and spiritual therapies.

3. THE ORIGINS OF ILLNESS AND CARCINOGENESIS

Ayurveda delineates several phases of carcinogenesis as chronic inflammatory and refractory conditions with the potential for malignancy, precancerous development, or probable malignancy, granthi (benign glandular enlargement), and arbuda [10]. Ayurveda posits that cancer arises from lifestyle missteps, including the consumption of unhealthy foods, inadequate hygiene, and detrimental behaviors, or from physical trauma, all of which disrupt the equilibrium of vata, pitta, and kapha, leading to damage to the inner dermal layer (rohini, the sixth layer of the skin) and the development of aberrant vascular structures. At this stage, early granthi or arbuda may manifest as bubble-shaped glandular growths. Granthi is characterized as a rounded, firm, and protruding mass, resulting from the exacerbation of vata and kapha, which disrupts the muscle, blood, and adipose tissues. Arbuda is characterized as a huge, round, muscular, inflexible, deeply entrenched, and slowly developing mass resulting from the exacerbation of doshas that impair the muscle, blood, and adipose tissues. Both kind of edema may be classified as inflammatory or non-inflammatory, depending on the doshas implicated. Tridoshic tumors are often malignant due to the loss of mutual coordination among the three primary bodily humors, leading to a pathological state. Numerous indications and symptoms resulting from cancer development have been well documented, including anemia, cachexia, and appetite loss fig 1.

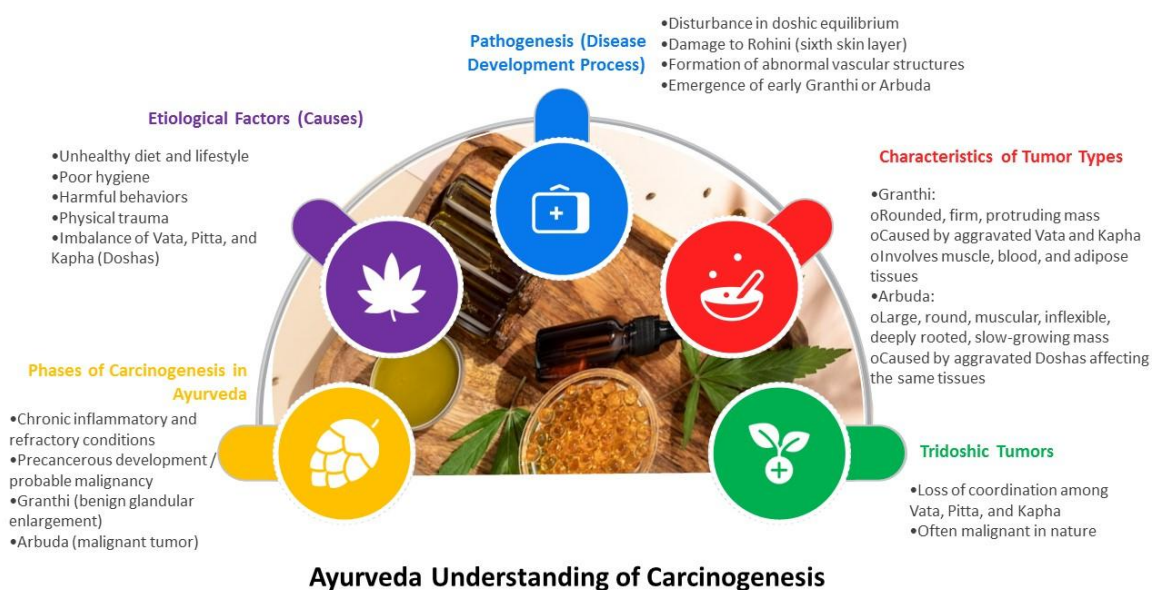


Figure 01: Ayurvedic Understanding of Carcinogenesis

4. CORRELATION BETWEEN AYURVEDIC AND CONTEMPORARY CANCER TREATMENTS

There are numerous parallels between the Ayurvedic understanding of cancer and contemporary oncological practices. Both systems emphasize surgical intervention followed by pharmacological therapy utilizing bioactive compounds-botanical in Ayurveda and synthetic in modern medicine. In present-day oncology, therapeutic strategies are designed to either activate or inhibit specific molecular and cellular signaling pathways. Over the past three decades, extensive research has identified several molecular targets, including oncogenes, tumor suppressor genes, growth factors such as epidermal growth factor (EGF) and vascular endothelial growth factor (VEGF), cancer-promoting enzymes like cyclooxygenase-2 (COX-2), matrix metalloproteinase-9 (MMP-9), and inducible nitric oxide synthase (iNOS), as well as key protein kinases

including AKT, mitogen-activated protein kinase (MAPK), and protein kinase C (PKC) [11].

Although these molecular entities were unknown thousands of years ago, Ayurvedic herbal formulations appear to influence many of these same pathways. Several herbs traditionally used in Ayurveda have now been found to modulate COX-2 activity or expression, demonstrating a convergence between ancient empirical knowledge and modern molecular pharmacology. The identification and development of novel synergistic anticancer agents from these botanicals could further enhance the efficacy of current therapeutic regimens. The use of *Vinca rosea* (Madagascar periwinkle) for cancer treatment is well documented in Ayurvedic texts. Modern pharmacological research has validated this practice, isolating vincristine and vinblastine-potent alkaloids now widely employed in the management of various malignancies. Similarly, compounds such as paclitaxel (from *Taxus brevifolia*) for breast and ovarian cancers and arsenic trioxide for acute myelogenous leukemia exemplify the successful scientific validation of traditional medicinal agents [12]. However, significant differences exist between ayurvedic and contemporary therapeutic paradigms. Modern oncology primarily relies on single-compound drugs that target specific pathways (e.g., paclitaxel, vincristine, etoposide), whereas ayurveda employs whole plant extracts that contain multiple active constituents acting in synergy. The enhanced toxicity often observed in modern chemotherapy may, in part, arise from the absence of complementary phytoconstituents present in whole-plant preparations that modulate bioactivity and reduce adverse effects.

Ayurveda traditionally utilizes polyherbal formulations, combining several plants to achieve a balanced therapeutic effect—an approach conceptually similar to combination chemotherapy regimens such as CHOP (Cyclophosphamide, Doxorubicin, Vincristine, Prednisone) for non-Hodgkin's lymphoma, ABVD (Adriamycin, Bleomycin, Vinblastine, Dacarbazine) for Hodgkin's disease, and CMF (Cyclophosphamide, Methotrexate, 5-Fluorouracil) for breast cancer. Each Ayurvedic formulation comprises multiple phytochemicals that act synergistically, enhancing therapeutic efficacy while minimizing toxicity. These formulations are often administered with anupanas-specific adjuvants such as ginger water, cumin decoction, or tulsi (*Ocimum sanctum*) extract—which enhance absorption, potentiate efficacy, and mitigate toxicity through buffering or antioxidant mechanisms [13]. The enclosure of these adjuncts reflects Ayurveda's sophisticated consideration of synergy, bioavailability, and detoxification. Moreover, Ayurvedic medicine holistically considers the interactive, physiological, and psychological scopes of illness, addressing the entire mind-body continuum. This integrative viewpoint aligns increasingly with modern oncology's evolving focus on psychosocial oncology, recognizing the influence of mental and emotional well-being on treatment outcomes. Practices such as yoga, meditation, and prayer therapy rooted in ayurvedic philosophy are now being incorporated into several leading cancer care centers worldwide, reflecting a growing convergence between traditional and modern healing paradigms.

5. NUTRITIONAL AND BOTANICAL ADJUSTMENTS

Ayurvedic nutrition emphasizes natural, minimally processed foods, seasonal dietary patterns, and the medicinal use of herbs and spices.

- **Turmeric (*Curcuma longa*):** Curcumin, the principal bioactive compound in turmeric, inhibits the nuclear factor-kappa B (NF-κB) and cyclooxygenase-2 (COX-2) pathways, thereby reducing inflammation and tumor proliferation. Studies on colorectal cancer (CRC) models demonstrate that curcumin supplementation can reduce polyp growth by approximately 40% [14].
- **Ginger (*Zingiber officinale*):** Ginger constituents modulate apoptotic signaling by downregulating B-cell lymphoma 2 (Bcl-2) expression, contributing to enhanced cancer cell apoptosis and reduced proliferation.

Overall, curcumin and similar phytoconstituents illustrate how Ayurvedic dietary interventions can mitigate oxidative stress and inflammatory pathways associated with carcinogenesis.

- **Ashwagandha (*Withania somnifera*):** Augments natural killer (NK) cell activity and moderates oxidative stress through the action of withanolides, foremost to improved immune surveillance.
- **Tulsi (*Ocimum sanctum*):** Encompasses eugenol, a compound with chemo-preventive possible that aids in detoxifying carcinogens and moderating metabolic enzymes.
- **Guggul (*Commiphora mukul*):** Validates lipid-lowering effects and reduces estrogen levels, thereby mitigating obesity-related and hormone-dependent cancer risks.
- **Triphala:** A classical Ayurvedic formulation known to activate glutathione-S-transferase (GST), leading to a 35% reduction in benzo[a]pyrene-induced cancers in preclinical studies.

Panchakarma (Detoxification Process)

Panchakarma meaning “five actions”—is a cornerstone Ayurvedic detoxification technique encompassing therapies such as Virechana (purgation). This procedure facilitates the abolition of ama (metabolic toxins) and has been associated with a reduction in oxidative DNA damage markers such as 8-hydroxy-2'-deoxyguanosine (8-OHdG). Such detoxification aids in restoring cellular homeostasis and optimizing physiological repair mechanisms [15].

Yoga and Meditation

Mind–body interventions form an integral part of Ayurveda. Clinical studies indicate that yoga practice (60 minutes per session, three times weekly) enhances natural killer cell activity appreciably among breast cancer patients. Meditation contributes to a 15% reduction in oxidative stress biomarkers such as malondialdehyde (MDA) in cancer survivors. Collectively, these practices reduce systemic inflammation, improve mood, and enhance immune resilience during cancer therapy and recovery [16].

Alignment of Circadian Rhythms

Ayurvedic Dinacharya emphasizes synchronizing biological activities with circadian cycles, recognizing the physiological importance of light–dark rhythm alignment. Disruption of circadian rhythms—commonly observed in sedentary or shift-working populations—can suppress melatonin secretion, thereby increasing susceptibility to oncogenic processes. Restoration of melatonin homeostasis, achieved through regulated sleep and lifestyle patterns, has been shown to inhibit tumor angiogenesis and support metabolic stability [17].

6. SYNERGISTIC POTENTIAL OF AYURVEDIC AND ALLOPATHIC MODALITIES

A growing body of evidence supports the therapeutic efficacy of traditional methodologies and plant-derived compounds in managing a wide range of other diseases and cancer. Several traditional methodologies and botanicals have demonstrated promising pharmacological potential. *Mimosa pudica* L., *Mangifera indica* L., *Cyperus scariosus*, *Vernonia amygdalina* Del., and *Cannabis sativa* L., exhibited bioactive properties beneficial in treating conditions such as conjunctivitis and other inflammatory disorders [18]. Ethnobotanical surveys, including those conducted in the Sakaldiha block, have documented the medicinal use of these species in traditional healing practices. Recent advancements also highlight the incorporation of *Vigna radiata* Linn. (Spring Green Gram) in integrative medicine, as well as the application of targeted oncological interventions using monodisperse gold nanoparticles [19]. These innovations exemplify the convergence of phytotherapy with modern biomedical technologies, offering new possibilities for less toxic, multimodal, and personalized cancer treatment approaches. Several Ayurvedic herbs have demonstrated significant potential in supporting cancer therapy through immunomodulation, radioprotection, chemoprotection, and sensitization. *Withania somnifera* and *Tinospora cordifolia* are well-established immunostimulants that enhance systemic immunity during cancer-related immunosuppression [20], while other commonly used plants—including *Asparagus racemosus*, *Ocimum sanctum*, *Picrorhiza kurroa*, *Embolica officinalis*, *Piper longum*, and *Terminalia chebula*—further support immune resilience and physiological balance. Formulations such as *Brahma rasayana* have shown myeloprotective effects against chemotherapy- and radiation-induced cytotoxicity, and their nontoxic profiles make them advantageous as adjuvant therapies. Botanicals like *Aegle marmelos* (bael), *Curcuma longa* (turmeric), *Zingiber officinale* (ginger), *Triphala*, and *Podophyllum hexandrum* exhibits radioprotective and chemoprotective properties, reducing treatment-associated toxicity. Certain herbs including *guduchi*, *ashwagandha*, *amla*, *neem*, *bael*, *Plumbago rosea*, and *curcumin* as well as polyherbal formulations such as *Semecarpus lehyam*, have also demonstrated radio and chemosensitizing effects, enhancing the susceptibility of cancer cells to conventional therapies [21]. These findings highlight the multifaceted role of Ayurvedic adaptogens and herbal formulations in optimizing cancer treatment outcomes by modulating immunity, protecting normal tissues, and potentiating therapeutic efficacy.

The integration of Ayurvedic and allopathic approaches in cancer therapy represents a progressive and holistic paradigm in oncology. Clinical and experimental studies increasingly support the combined use of Ayurvedic formulations alongside standard chemotherapeutic and radiotherapeutic regimens. For instance, *Withania somnifera* (Ashwagandha) extracts have been shown to enhance the efficacy of paclitaxel and cisplatin while mitigating their myelotoxic and neurotoxic side effects [22]. Similarly, *Curcuma longa* (curcumin) has demonstrated synergistic effects with 5-fluorouracil and doxorubicin through modulation of NF-κB and apoptotic pathways, reducing chemoresistance [23]. The combination of *Tinospora cordifolia* with conventional therapy has been associated with improved hematological profiles and decreased mucositis in head and neck cancer patients. Clinical trials using *Triphala* as an adjuvant have reported improved antioxidant status and reduced genotoxicity during radiotherapy [24]. Integrative cancer centers in India, such as those at AIIMS and Tata Memorial Hospital, have also explored multi-modal regimens incorporating Rasayana therapy and yoga-based lifestyle interventions alongside chemotherapy, demonstrating enhanced patient tolerance and quality of life [25]. Collectively, such evidence underscores the potential of integrative oncology to bridge traditional wisdom and modern science, advancing personalized, less toxic, and more resilient cancer care models.

7. FUTURE OUTLOOK

Despite the growing recognition of Ayurveda's integrative potential in cancer management, several challenges must be addressed to ensure its safe and effective incorporation into mainstream oncology. Standardization remains a major obstacle, as variations in plant species (e.g., *Withania somnifera* leaf versus root), preparation techniques (such as decoction versus powder), and dosage levels (e.g., curcumin 500 mg/day versus 1 g/day) limit reproducibility and comparability across studies [26]. Rigorous clinical trials and quality control measures are required to establish consistency in formulation

and efficacy. Contraindications and herb drug interactions present another concern; for instance, turmeric may interfere with the pharmacodynamics of certain chemotherapeutic agents, underscoring the importance of interdisciplinary collaboration between oncologists, pharmacologists, and Ayurvedic practitioners to ensure patient safety. Furthermore, evidence based validation remains constrained, as most findings derive from preclinical models rather than large-scale human trials. Although studies such as those on Triphala indicate up to a 35% reduction in tumor incidence in experimental models, clinical data remain limited ^[27]. According to the GRADE assessment, the quality of evidence supporting curcumin's efficacy is classified as moderate, while that for circadian alignment (Dinacharya) remains low, highlighting the need for more robust, well-designed human studies to substantiate these promising findings.

8. CONCLUSION

This review examines the Ayurvedic approach to cancer diagnosis and management, emphasizing its relevance in contemporary healthcare. It highlights that common cancers in Western populations such as colon, lung, breast, and prostate cancers exhibit substantially lower incidence rates, potentially reflecting dietary patterns, vegetarianism, and widespread adherence to Ayurvedic practices. While modern oncology largely focuses on molecularly targeted, reductionist therapies, Ayurveda provides a holistic framework that integrates nutrition, detoxification, lifestyle regulation, and mental well-being to prevent and manage cancer. The review underscores the potential of combining traditional Ayurvedic practices with emerging scientific paradigms to develop more effective, integrative cancer strategies. It also emphasizes the need for rigorous clinical trials, standardization, and quality control to validate ancient knowledge and align it with contemporary evidence-based oncology.

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