

From Ancient Medicine to Modern Medicine: Ayurvedic Concepts of Health and Their Role in Inflammation and Cancer

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² Recent statistics indicate that the overall cancer incidence in the United States, in spite of billions of dollars spent on research each year, has not changed significantly in the last half-century. Cancers of the prostate, breast, lung, and colon, although most common in the Western world, are least common in the Eastern world. Allopathic medicine commonly practiced currently is only 100 years old. Although traditional medicine has been around for thousands of years, no integration exists between it and allopathic medicine. Ayurveda, the science of long life and one of the most ancient medical systems still practiced on the Indian subcontinent, can be used in combination with modern medicine to provide better treatment of cancer. This review focuses on the ayurvedic concept of the causes of cancer and its linkage with inflammation, diagnosis, prevention, and treatment. How ayurvedic medicine can be integrated with allopathic medicine is also discussed in this review.

Key words: *alternative, ayurvedic medicine, botanicals, cancer, complementary, herbs, inflammation, integrated, natural, phytotherapy, treatment*

A recent survey of the global incidence of cancer shows that the age-adjusted cancer incidence in the United States is above 300 cases per 100,000 population, whereas that in Asian countries is less than 100 cases per 100,000. Also, although the incidence of cancer of the prostate, lung, breast, and colon is highest in Western countries, it is lowest in Eastern countries.¹⁻³ In spite of the billions of dollars spent on cancer research and the availability of the best health care in the world, the reason for such a high incidence of cancer in the United States is unclear. Lifestyle has been named as one of the major contributors to the incidence of cancer. The higher incidence of cancer among immigrants from the Eastern world to the Western world

further emphasizes the role of lifestyle.^{4,5} Additionally, cancer is a highly complex disease whose development may take as many as 20 to 30 years before it can be detected.

Although modern science has made some major strides in understanding cancer and its molecular basis, the knowledge about how to prevent or treat cancer is still lagging behind. Although interruption of a cell signaling pathway, also called monotherapy, has been the paradigm approach until now, experience in the last few years has revealed that multitargeted therapy has a better chance for success. Modern medicine is evidence based and practices the use of a discrete, well-defined chemical entity for the treatment of given diseases. However, this medicine is very new in its origin and is approximately a century old. Aspirin is perhaps one of the oldest medicines; it was discovered in 1895 and is used even today. In contrast, whether traditional medicine that has existed for thousands of years has any relevance in today's world or can be used in combination is the focus of this review. This review, in particular, concentrates on the ayurvedic approach for the prevention and treatment of cancer and inflammation.

What Is Ayurveda?

Ayurveda, which means science of long life, is at least a 5,000-year-old system of Indian medicine (1500–1000 BC)

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designed to promote good health and longevity rather than to fight disease and was practiced by physicians and surgeons (called *bheshaja* or *vaidya*). Until 700 BC, this science was orally discussed between sages and physicians (Figure 1A). Thereafter, two different textbooks were assembled: one by “Charaka” is called *Charaka Samhita*⁶ and the other by “Sushruta” is called *Sushruta Samhita*.⁷ Whereas *Charaka Samhita* deals with the etiology, symptomatology, pathology, prognosis, and medical management of disease, *Sushruta Samhita* deals with various surgical instruments and procedures.

Ayurvedic Concept of Health

Ayurveda is a medical system that deals not only with body but with the mind and spirit as well. According to ayurveda, most diseases connected with the psychophysiological and pathologic changes in the body are caused by imbalance in three different dosha (ie, vata, pitta, and kapha; Figure 1B).⁸ The fundamental aim of ayurvedic therapy is to restore the balance between these three major body systems.^{6,7,9–11} Any imbalance can lead to inflammation (also called *sopha*). Almost seven different types of inflammation have been described in ayurveda (Figure 1C). The ayurvedic definition of *pittaja sopha* (inflammation) encompasses the modern concept of inflammation, which is defined as redness, pain, heat, loss of function, and swelling (Figure 1D). The balanced coordination of body, mind, and consciousness is the ayurvedic definition of health.

Pathogenesis of Inflammation and Cancer

Ayurveda describes different stages of tumorigenesis as chronic inflammatory and intractable diseases with the possibility of developing malignancy, precancerous growth or probable malignancy, *granthi* (benign glandular swelling), and *arbuda* (definite malignancy; Figure 1E). According to ayurveda, cancer results from lifestyle errors, such as unhealthy foods, poor hygiene, or poor behavior, or from physical trauma, all leading to imbalances of vata, pitta, and kapha, resulting in injury to the inner layer of the dermis (*rohini*, the sixth layer of the skin) and the formation of abnormal branches of blood vessels.¹² In this stage, early *granthi* or *arbuda* can develop, in the form of bubble-shaped glandular growths. *Granthi* has been described as a round, hard, and bulging swelling, produced owing to the aggravation of vata and kapha vitiating the muscle, blood, and fatty tissues. *Arbuda* has been described as a round, large, muscular, immovable, deeply rooted,

slowly growing swelling produced owing to the aggravation of doshas vitiating the muscle, blood, and fatty tissues. Both types of swelling can be inflammatory or noninflammatory, based on the doshas involved. Tridoshic tumors are usually malignant because all of the three major body humors lose mutual coordination, resulting in a morbid condition. Various signs and symptoms arising owing to the progression of cancer have been described in detail, for example, anemia, cachexia, and loss of appetite.

Ayurvedic Concept of Treatment of Cancer

The therapeutic approach involves *prakritistani chikitsa* (health maintenance), *rasayana chikitsa* (restoration to normal), *naishthiki chikitsa* (spiritual approach), and *roghanashani chikitsa* (disease cure; Figure 2A). There was a careful assessment of the patient prior to selecting treatment, and, accordingly, different treatment protocols were chosen. The principles of patient safety were foremost, including meticulous aseptic techniques used for surgery (eg, careful boiling of instruments, cleaning of hands).⁷ Treatment involves the surgical removal of tumor, herbal remedies, dietary modification, and spiritual treatment (eg, detoxification, rejuvenation, prayers, music therapy, aromatherapy, gem therapy, sound therapy, stress relief, meditation, yoga, and astrology) (Figure 2B).

Shodhana chikitsa (strong purifying modalities), which eliminates vitiated doshas, has been primarily used for medical management of cancer. Both internal and external purifications are given by five techniques known collectively as *panchakarma chikitsa* (eg, *vamana*, *virechana*). The purification (*sodhana*) therapy is first started with *oleation*, which is the application of medicated oils to the body. If the patient has a predominance of kapha, then the oil is prepared with a *kaphaghna* (kapha destroying) drug. Similarly, if pitta is predominant, then the oil is processed with a *pittaghna* (pitta destroying) drug. Depending on the predominant imbalance, this is followed by emetic therapy to treat excess kapha, purgation therapy to balance excess pitta, and administration of herbal decoction enema to reduce the excess vata dosha. Modern medicine also uses cytotoxic chemotherapy, radiotherapy, and surgical removal of tumors, which are mainly *shodhana* measures and mainly kapha reducing.

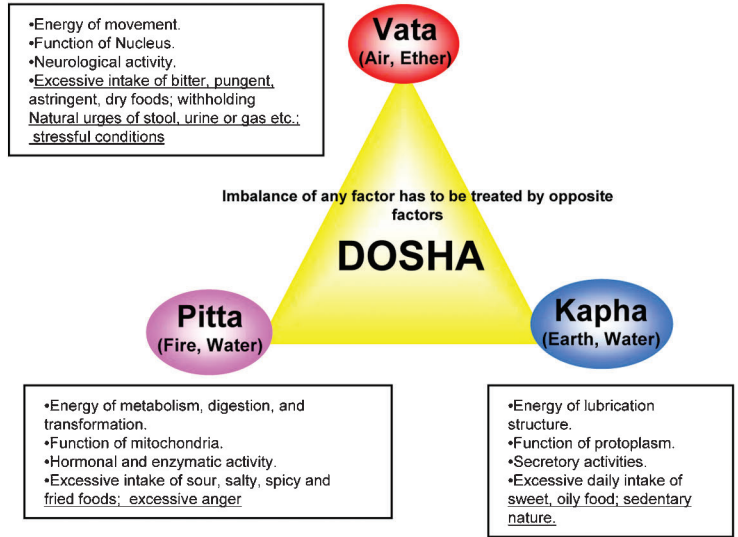
Shamana chikitsa (palliative treatment) pacifies dosha and gradually relieves the disease. However, this treatment is prescribed only to weaker patients, for whom *shodhana chikitsa* is contraindicated. It is important to maintain the strength of the patient during the treatment. For immunomodulation, ayurveda recommends use of

A



Ancient sages and physicians teaching and discussing Ayurveda

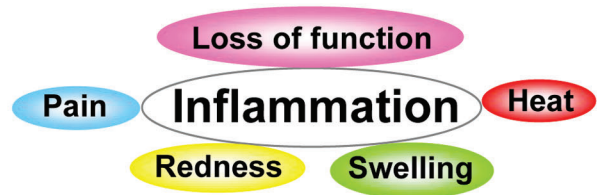
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D



E

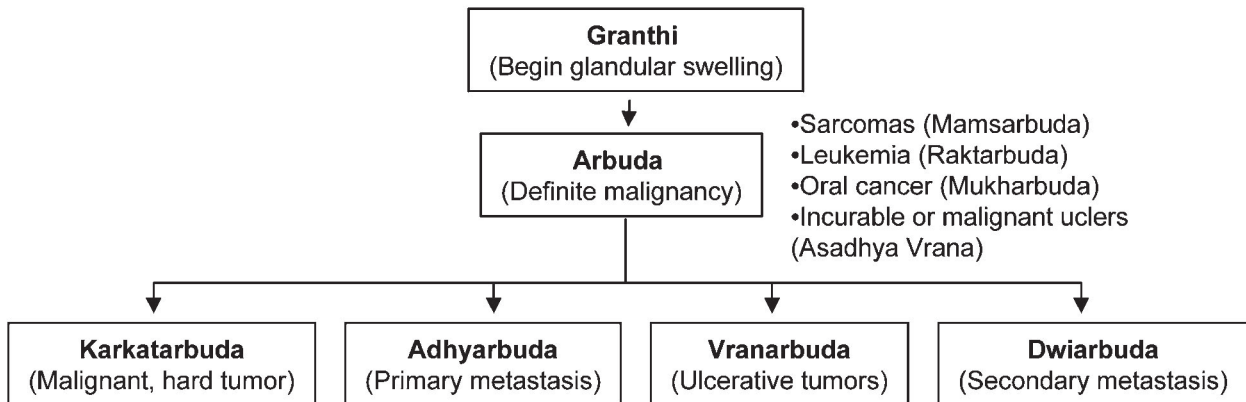


Figure 1. Ayurvedic concept of inflammation and cancer. A, Teaching of ayurveda in ancient times. B, The role of tridoshas in the pathogenesis of the disease. Aggravating factors are *underlined*. C, Different types of sophas (inflammation/swelling). D, Different manifestations of inflammation. E, Development and progression of cancer through different stages.

A



B



Figure 2. Ayurvedic concept of treatment of inflammation and cancer. *A*, Multiple approaches for the prevention and treatment of cancer. *B*, Different therapeutic modalities currently employed for the treatment of cancer.

appropriate rasayana chikitsa, with adaptogenic, immunopotentiating, and antioxidant herbs such as amalaki, guduchi, pippali, chyavanprash, ashvagandha, and Brahma rasayana (Table 1 and Figure 3).^{13–18}

Rejuvenative therapies that are strengthening or restorative in nature are used to balance and remove any debility in the patient caused by the purification or cleansing. This is the final step prior to starting therapies specifically directed at the unbalanced doshas. Emotional support and psychotherapy are provided with yoga, meditation, prayers, and chanting, along with individualized nutrition plans and dietary interventions. Meditation

leads to emotional and stress release and detoxification of the cellular and tissue memories. Astrologic charting is done to see the planetary positions and the effect of the benevolent and maleficent planets, and specific prayers, chants, and gem therapies are suggested accordingly. Exercise and diet are important adjuncts to the primary treatment. Vigorous exercise, however, is contraindicated in lean and weak patients. Instead, patients are advised to perform specific yoga positions that are believed to benefit them in mind and body with the least physical stress. Certain postures are believed to stimulate the internal organs and glands and improve immunity and organ

Table 1. List of Herbs Commonly Used by Ayurvedic Doctors for the Prevention and Treatment of Cancer

Scientific Name	Hindi Name	English Name
Abrus precatorius	Gunja	Coral bead vine
<i>Albizia lebbek</i>	Sirisha	Rain tree
Allium sativum	Lasuna	Garlic
Aloe vera	Kumari	Aloe
<i>Alstonia scholaris</i>	Sapta parni	Milky pine
<i>Anacardium occidentale</i>	Kajutaka	Cashew
<i>Anona squamosa</i>	Sitaphala	Custard apple
<i>Aristolochia indica</i>	Ishwari	Birthwort
<i>Asparagus racemosus</i>	Shatawari	Asparagus
<i>Azadiracta indica</i>	Nimba	Margosa tree
<i>Bacopa monnieri</i>	Brahmi	Indian penny wort
<i>Baliospermum montanum</i>	Danti	
<i>Bauhinia racemosa</i>	Kanchanara	Mountain ebony
<i>Berberis aristata</i>	Daru haridra	Indian ophthalmic barberry
<i>Berginia ligulata</i>	Pashana bedi	
Boswellia serrata	Shallaki	Indian olibanum
<i>Calotropis gigantea</i>	Arka	Gigantic swallow wort
<i>Cedrus deodara</i>	Devadaru	Devdar
<i>Centella asiatica</i>	Mandukaparni	Gotu kola
Curcuma longa	Haridra	Turmeric
<i>Cymbopogon citratus</i>	Bhustrina	Lemongrass
<i>Datura metel</i>	Dhattura	Angel's trumpet
<i>Euphoria hirta</i>	Dugdika	Hairy spurge
<i>Withania somnifera</i>	Ashwagandha	Indian ginseng
<i>Heliotropium indicum</i>		White clary
<i>Holarrhena antidysenterica</i>	Kutaja	Kurchi tree
<i>Hygrophila spinosa</i>		Kule khara
<i>Inula cappa</i>		Sheep's ear
<i>Jasminum auriculatum</i>	Juui	Jasmine
<i>Leea macrophylla</i>		Dinda
<i>Luffa cylindrical</i>		Dishrag gourd
<i>Mallotus philippensis</i>		Kamala tree
<i>Manilkara hexandra</i>		Khirni
<i>Melia azadirachta</i>	Maha nimba	Neem tree
<i>Moringa oleifera</i>	Shigru	Horseradish tree
<i>Nerium indicum</i>	Kara veera	Oleander
<i>Nigella sativa</i>	Krishna jeeraka	Black cumin
<i>Occimum sanctum</i>	Tulasi	Holy basil
<i>Paederia foetida</i>	Gandha prasarani	Chinese fever vine
<i>Phyllanthus fraternus</i>	Niruri	Leafflower
<i>Picrorrhiza kurroa</i>	Katuki	Kutki
<i>Piper betle</i>	Nagavalli	Betel leaf pepper
<i>Pisum sativum</i>	Kalaya	Garden pea
Plumbago zeylanica	Chitraka	Leadwort
<i>Plumbago rosea</i>	Rakta chitraka	Radix plumbago

Table 1. Continued

Scientific Name	Hindi Name	English Name
<i>Podophyllum emodi</i>		May apple
<i>Rubia cordifolia</i>	Manjistha	Indian madder
<i>Saussurea lappa</i>	Kustha	Costus root
<i>Saraca indica</i>	Ashoka	Ashoka tree
<i>Semecarpus anacardium</i>	Bhallataka	Varnish tree
<i>Tylophora asthmatica</i>	Aja dweshi	Indian ipecac
<i>Vernonia species</i>	Sahadevi	Ironweed
Vinca rosea	Sadabahar	periwinkle

Adapted from references 6, 7, 9–12, 14, and 21.

Names indicated in boldface represent plants whose anticancer role is supported by modern scientific evidence.

function. Diet is prescribed according to age, body constitution, season, and environment, as well as the socioeconomic status of the patient.

At the time of Atreya and Dhanwantri (seventh century BC), surgery was considered one of the best methods of treatment for arbuda. They found that herbal medicine treatments against cancer, either in the form of granthi or arbuda, were beneficial only in the beginning stage. Nonetheless, they recorded a group of successful treatments for use against gulmas (cystic tumors) and neoplasms of individual organs.^{6,7,9–11} Surgical treatment included external and internal cleansing, surgical opening and drainage of the tumor, surgical excision of the tumor, cauterization with alkalis and acids to prevent recurrences, and postoperative care for healing of the wounds. Six types of surgical operations were described: incision, puncturing, excision, scraping, scarification, and suturing. Excellent sterile practices were followed to minimize infections and other complications of surgery. Physicians were warned against leaving remnants of tumor tissue, leading to recurrence and metastasis and to the patient's demise (similar to a remnant spark of fire leading to the whole house being burned down by fire).⁷

In the ama (unripe) stage of granthi, a treatment similar to sophia was recommended. Different kinds of sweda (fomentation), upanaha (poultice), and lepa (pastes) were recommended according to the vitiated doshas. After the tumor ripens (pakva), it should be cut open and drained of pus and the ulcer washed with the herbal decoctions and purified, followed by cauterization by heat or alkalis and the use of medicated oil. With the introduction of rasa shastras (the science of heavy metal processing, such as mercury and arsenic^{19,20} [bhasmas]) by The Siddhas (600–1200 AD), many cancers were considered curable, especially if they were treated in the early stages.

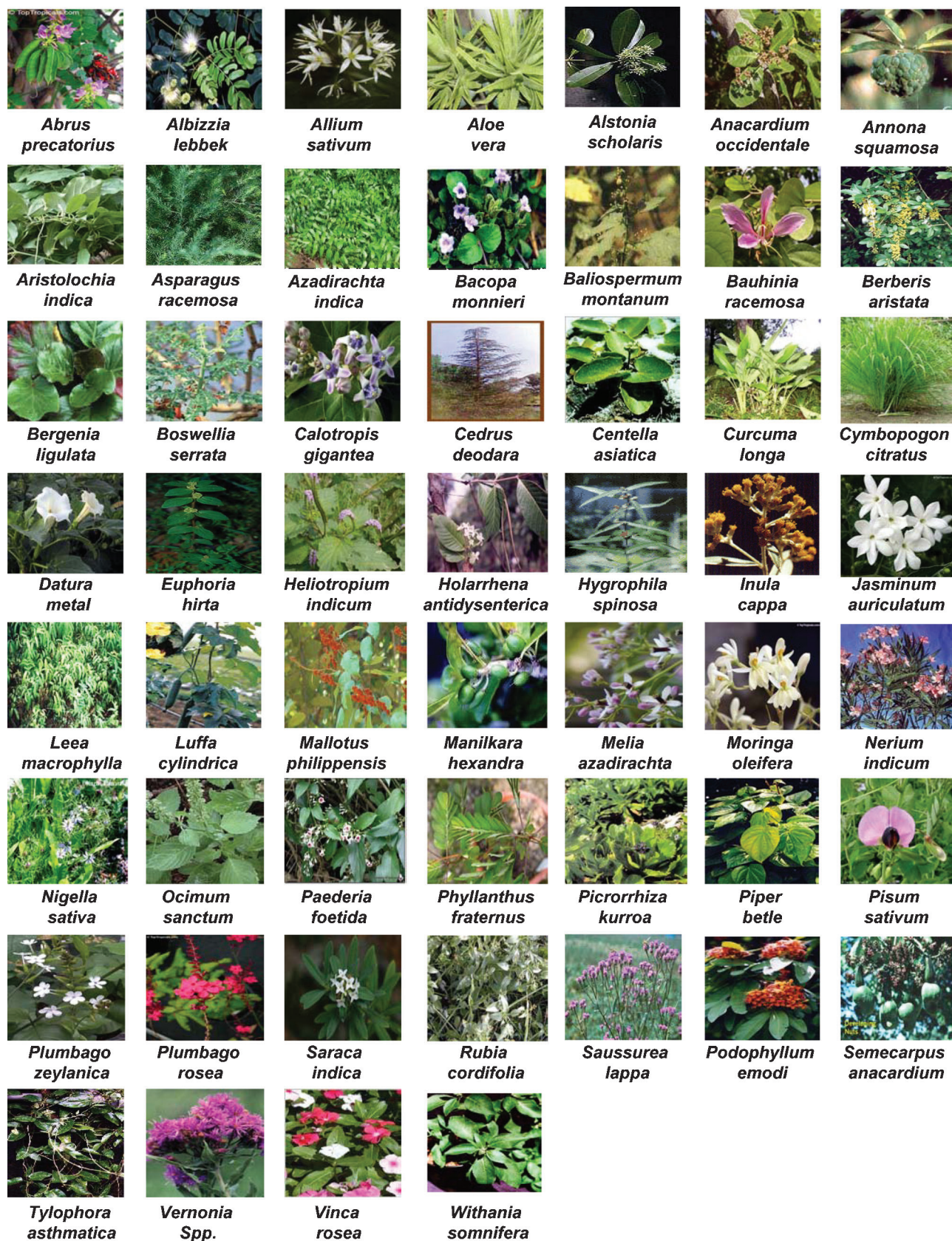


Figure 3. A picture of ayurvedic plants that have potential in the prevention and treatment of cancer.

This was true for both the basic common neoplasms and neoplasms of the individual organs.

Anticancer Herbs

Many herbs have been described for the treatment of cancer (see Table 1 and Figure 3).^{21,22} These herbs are classified based on their rasa (taste) as katu (pungent), tikta (bitter), or kashaya (astringent) or other properties as laghu (light), ruksha (dry), teekshna (sharp, penetrating), and usna (hot) guna (biophysical property) and usna veerya (biopotency) and katu (pungent) vipaka (catabolic effects).²³

Relationship of Ayurvedic Treatment to Modern Treatment of Cancer

Similarities

There are several common features between the ayurvedic concept of cancer and those currently practiced. These include surgery followed with treatment with drugs derived from plants. Cancer medicine currently practiced is meant to inactivate or activate specific molecules or cell signaling pathways. Within the last three decades, cancer-causing genes called oncogenes, cancer-suppressing genes (tumor suppressor genes), cancer growth factors (such as epidermal growth factor and vascular endothelial growth factor), cancer-promoting enzymes (such as cyclooxygenase [COX]-2, matrix metalloproteinase 9, inducible nitric oxide synthase), and cancer-causing protein kinases (AKT, mitogen-activated protein kinase [MAPK], protein kinase C) have been identified as targets. Although these targets were not known 5,000 years ago, the components of herbs used at that time now appear to target these molecules. For instance, nuclear factor κ B, which has been known to play a major role in tumorigenesis, is targeted by the components of several herbal remedies described in ayurveda (Table 2).²⁴⁻⁷⁰ Similarly, several herbs have been described in ayurveda that can suppress either expression of COX-2 or its activity.^{47,51,57,63,66,69,71-80} Development of new synergistic anticancer agents based on these herbs would be beneficial for modern treatment modalities. The use of *Vinca rosea* in the treatment of cancer is very well described in ayurveda. Modern medicine has shown that vincristine, derived from the plant *Vinca rosea*, can be used as a standard therapy for several cancers. Similarly, paclitaxel for breast and ovarian cancers and arsenic trioxide for acute myelogenous leukemia are being used

after they were scientifically proven to be effective by modern science.^{19,20}

Differences

Although modern science believes in using a single chemical entity for a particular cancer (eg, paclitaxel, vincristine, etoposide), ayurvedic treatment involves the use of whole plant extracts. It is possible that enhanced toxic effects associated with modern medicine are due to a lack of other components of the plant. Ayurveda usually recommends the use of several plant extracts in combination, which is somewhat similar to the combination of various chemical entities that are currently used for the treatment of cancer (eg, the CHOP [cyclophosphamide, hydroxydoxorubicin, Oncovin (vincristine), prednisone] regimen for non-Hodgkin's lymphoma; the ABVD [Adriamycin (doxorubicin), bleomycin, vinblastine, dacarbazine] regimen for Hodgkin's disease; and the CMF [cyclophosphamide, methotrexate, fluorouracil] regimen for breast cancer). Each herbal formulation contains multiple active principles that may operate synergistically, producing therapeutic benefits and lowering the risks on adverse effects. The preparations are then prescribed with certain anupanas (accompaniments) (eg, ginger or cumin water, tulsi extract) that have been shown to protect against unwanted toxicity owing to various mechanisms, including delivering trace elements^{81,82} and synergistic or protective effects owing to buffering between various constituents.

Ayurvedic medicine takes into consideration the behavioral, physiologic, and psychological effects of drugs on the whole mind-body complex. Modern medicine must start accepting and incorporating the mind and emotional aspects of the whole being while considering the treatment of an individual person. Already, yoga and meditation techniques and prayer therapy have started to be implemented in many major cancer treatment centers.⁸³

How Ayurvedic Medicine Can Be Integrated with Modern Medicine

Various aspects of ayurvedic therapy can be combined with modern treatments.

Diet and Lifestyle

Use of herbs every day in the diet (eg, ginger, turmeric, garlic, pepper, cloves, tulsi, saffron⁸⁴⁻⁸⁷ and taking seasonal detoxifiers and antioxidants such as triphala (K),⁸⁸ neem, and amla.^{15,88}

Table 2. Molecular Targets of Selected Ayurvedic Plants

Target	Herbs
Transcription factors	
Nuclear factor κ B	<i>Curcuma longa</i> , <i>Withania somnifera</i> , <i>Boswellia serrata</i> , <i>Aloe vera</i> , <i>Allium sativum</i> , <i>Saussurea lappa</i> , <i>Ocimum sanctum</i> , <i>Plumbago zeylanica</i> , <i>Brassica oleracea</i> , <i>Semicarpus anacardium</i> , <i>Phyllanthus amarus</i> , <i>Rumex crispus</i> , <i>Cydonia oblonga</i> , <i>Punica granatum</i> , <i>Coriandrum sativum</i> , <i>Vitis vinifera</i> , <i>Gmelina arborea</i> , <i>Commiphora mukul</i> , <i>Juniperus communis</i> , <i>Citrullus colocynthis</i> , <i>Syzygium cumini</i> , <i>Brassica campestris</i> , <i>Indigofera tinctoria</i> , <i>Bergenia ligulata</i> , <i>Dysoxylum binectariferum</i> , <i>Boswellia serrata</i> , <i>Salvia officinalis</i> , <i>Foeniculum vulgare</i> , <i>Cassia angustifolia</i> , <i>Glycine max</i> , <i>Tanacetum parthenium</i> , <i>Zingiber zerumbet</i>
Signal transducer and activator of transcription (STAT)-3	<i>Curcuma longa</i> , <i>Citrullus colocynthis</i> , <i>Indigofera tinctoria</i>
Nrf-2	<i>Curcuma longa</i> , <i>Vitis vinifera</i>
Growth factors	
Epidermal growth factor (EGF)	<i>Curcuma longa</i>
Transforming growth factor β	<i>Curcuma longa</i>
Vascular endothelial growth factor	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Commiphora mukul</i> , <i>Indigofera tinctoria</i> , <i>Plumbago zeylanica</i> , <i>Vitis vinifera</i> , <i>Gmelina arborea</i>
Her2/neu Receptors	<i>Aloe vera</i> , <i>Rumex crispus</i>
Androgen receptor	<i>Curcuma longa</i> , <i>Aloe vera</i> , <i>Vitis vinifera</i>
EGF-R	<i>Curcuma longa</i>
Estrogen receptor α	<i>Curcuma longa</i>
Fas-R	<i>Curcuma longa</i>
Invasion/metastasis	
Matrix metalloproteinases	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Aloe vera</i> , <i>Plumbago zeylanica</i> , <i>Rumex crispus</i> , <i>Gmelina arborea</i> , <i>Commiphora mukul</i> , <i>Indigofera tinctoria</i> , <i>Dysoxylum binectariferum</i> , <i>Salvia officinalis</i> , <i>Zingiber zerumbet</i>
Inducible nitric oxide synthase	<i>Curcuma longa</i> , <i>Phyllanthus amarus</i> , <i>Cydonia oblonga</i> , <i>Vitis vinifera</i> , <i>Tribulus terrestris</i>
Nitric oxide	<i>Saussurea lapparis</i> , <i>Boswellia serrata</i> , <i>Nigella sativa</i> , <i>Aegle marmelos</i> , <i>Cydonia oblonga</i>
Cyclooxygenase 2	<i>Curcuma longa</i> , <i>Withania somnifera</i> , <i>Boswellia serrata</i> , <i>Plumbago zeylanica</i> , <i>Phyllanthus amarus</i> , <i>Vitis vinifera</i> , <i>Coptis teeta</i> , <i>Tribulus terrestris</i> , <i>Tiospora smilacina</i> , <i>Commiphora mukul</i> , <i>Indigofera tinctoria</i> , <i>Salvia officinalis</i> , <i>Zingiber zerumbet</i> , <i>Nigella sativa</i> , <i>Cinnamomum cassia</i> , <i>Curcuma zedoary</i>
Inflammatory cytokines	
Tumor necrosis factor α	<i>Curcuma longa</i> , <i>Saussurea lappa</i> , <i>Curcuma zedoary</i>
Interferon- γ	<i>Cydonia oblonga</i>
Interleukin (IL)-1	<i>Curcuma longa</i> , <i>Saussurea lappa</i> , <i>Phyllanthus amarus</i> , <i>Vitis vinifera</i>
IL-4	<i>Gmelina arborea</i> , <i>Medicago sativa</i> , <i>Curcuma zedoary</i> , <i>Indigofera tinctoria</i>
IL-6	<i>Curcuma longa</i> , <i>Vitis vinifera</i>
IL-8	<i>Curcuma longa</i> , <i>Saussurea lappa</i> , <i>Vitis vinifera</i>
Protein kinase	
Extracellular signal-regulated kinase	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Saussurea lappa</i> , <i>Rumex crispus</i> , <i>Cydonia oblonga</i> , <i>Vitis vinifera</i> , <i>Cassia angustifolia</i>
c-Jun N-terminal kinase (JNK)	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Saussurea lappa</i> , <i>Coriandrum sativum</i> , <i>Vitis vinifera</i>
Mitogen-activated protein kinase (MAPK)	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Saussurea lappa</i> , <i>Coriandrum sativum</i> , <i>Foeniculum vulgare</i>
Protein kinase C	<i>Curcuma longa</i> , <i>Vitis vinifera</i>
AKT	<i>Curcuma longa</i> , <i>Gmelina arborea</i> , <i>Indigofera tinctoria</i>

Table 2. Continued

Target	Herbs
Enzymes	
Adenosine triphosphatase	<i>Curcuma longa</i> , <i>Alstonia scholaris</i>
Glutathione-S-transferase	<i>Curcuma longa</i>
Apoptosis	
Bcl-2	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Plumbago zeylanica</i> , <i>Brassica oleracea</i> , <i>Vitis vinifera</i> , <i>Gmelina arborea</i> , <i>Commiphora mukul</i> , <i>Brassica compestris</i> , <i>Indigofera tinctoria</i> , <i>Zingiber zerumbet</i>
Bcl-xl	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Plumbago zeylanica</i> , <i>Brassica oleracea</i> , <i>Vitis vinifera</i> , <i>Brassica compestris</i>
Bax	<i>Vitis vinifera</i>
Survivin	<i>Plumbago zeylanica</i> , <i>Vitis vinifera</i>
Caspases	<i>Aloe vera</i> , <i>Cymbopogon winterinus</i> , <i>Cymbopogon martini</i> , <i>Vitis vinifera</i> , <i>Cymbopogon citrus</i>
Cell cycle	
p53	<i>Curcuma longa</i> , <i>Vitis vinifera</i>
p21 ^{Cip1/WAF1}	<i>Vitis vinifera</i> , <i>Gmelina arborea</i> , <i>Glycyrrhiza glabra</i> , <i>Indigofera tinctoria</i>
Cyclin D1	<i>Curcuma longa</i> , <i>Boswellia serrata</i> , <i>Plumbago zeylanica</i> , <i>Vitis vinifera</i> , <i>Commiphora mukul</i> , <i>Indigofera tinctoria</i> , <i>Dysoxylum binectariferum</i> , <i>Salvia officinalis</i> , <i>Zingiber zerumbet</i> , <i>Vitis vinifera</i> , <i>Gmelina arborea</i>
Others	
Histone deacetylase	<i>Curcuma longa</i> , <i>Pisum sativum</i>

See references 24 to 70.

7 Piperine from black pepper has been shown to be a bioenhancing principle for many of the herbs.⁸⁹ Avoiding a nonvegetarian diet has been shown to be preventive for tumorigenesis.⁹⁰

Alleviation of Side Effects

Several herbs have been described in ayurveda that can alleviate some of the common side effects associated with modern medical treatment of cancer. For instance, *Bacopa monnieri* has been shown to strengthen mental faculties and helps manage insomnia or sleeplessness owing to stress.⁹¹ Similarly, an herbal combination based on the ancient rasayana formulations of *Withania somnifera*, *Asparagus racemosus*, *Hydrocotyle asiatica*, *Nardostachys jatamansi*, *Elettaria cardamomum*, *Tribulus terrestris*, *Zingiber officinalis*, and *Eclipta alba* could also be useful in the treatment of anxiety, tension, and insomnia. *Ocimum sanctum* is beneficial against stress and depression during cancer. Yoga, meditation, prayer, and chanting can help release mental and physical stress.⁸³

Cancer Cachexia

Ayurvedic herbs can also be used to diminish the side effects noted with modern treatments that substantially impact the quality of life of cancer patients.

Cancer-associated cachexia includes anorexia, chronic nausea, and change in body image. Anorexia or weight loss could be effectively managed by the commonly used rasayana herbs *Withania somnifera*, *Sida cordifolia*, *Asparagus racemosus*, *Vitis vinifera*, *Plumbago zeylanica*, *Tinospora cordifolia*, and *Zingiber officinale*. These herbs have been shown to improve appetite, food intake, malnutrition, fatigue, and sensation of well-being, which could elicit body-weight gain.^{13–15,85–88} Additionally, *Aegle marmelos*, *Holarrhena antidysenterica*, *Punica granatum*, *Cyperus rotundus*, *Embllica officinalis*, and *Plumbago zeylanica* can be used to manage cancer-associated diarrhea.⁹² Herbs such as *Terminalia chebula* could be useful against chronic constipation and digestive disorders, which are common in cancer patients and result in a loss of appetite.⁸⁸ Also, herbs such as *Zingiber officinalis*, *Eclipta prostrata*, *Embllica officinalis*, *Withania somnifera*, and *Piper longum* can be directed to correct nausea and vomiting.^{22,93} Studies have also shown that *Allium sativum* (garlic) could be helpful to manage pain and ache. Certain ayurvedic herbs, such as *Curcuma longa*, *Zingiber officinale*, *Glycyrrhiza glabra*, *Terminalia chebula*, *Ocimum sanctum*, and *Adhatoda vasica*, are used to control cough and shortness of breathe, especially for lung cancer patients.⁹⁴ Thus, the ayurvedic regimen rejuvenates the body tissues, tones up the body systems, and acts as a tonic to the body

against cancer cachexia. Because of this holistic approach toward total healing and health promotion, ayurvedic treatment has a great deal of promise in cancer therapy.

Immunomodulation and Adaptogen

Among the above-mentioned herbs, *Withania somnifera* and *Tinospora cordifolia* are also proven to be powerful immunostimulants, which could increase body resistance power during cancer-associated immunosuppression.¹⁶ Other herbs frequently used either singly or in formulations are *Asparagus racemosus*, *Ocimum sanctum*, *Picrorhiza kurroa*, *Emblica officinalis*, *Withania somnifera*, *Piper longum*, and *Terminalia chebula*.^{16–18}

Radioprotection and Chemoprotection

Brahma rasayana has been shown to be myeloprotective against chemotherapy and radiotherapy in cancer patients. The use of this nontoxic preparation as an adjuvant in cancer therapy will prove to be highly beneficial.^{13,14} Besides bael, turmeric, ginger, triphala, and *Podophyllum hexandra*,^{95,96} the other immunomodulating herbs mentioned above also show these properties.⁹⁷

Radiosensitization and Chemosensitization

Various herbs, such as guduchi, ashwagandha, amla, neem, bael, *Plumbago rosea*, and curcumin,⁹⁸ and polyherbals, such as semecarpus lehyam,⁹⁹ have been shown to possess radio- and chemosensitizing properties.

Clinical Research

Treatment according to ayurveda is very individualized, thereby making it difficult to conduct a large population-based clinical study. Thus, not many randomized, controlled, and double-blind clinical trials are available.^{100,101} Many anecdotal and case reports are available that show the efficacy of the herbs and the treatments used. The individualized therapies are sometimes poorly documented, unable to be accepted in the standardized Western field.

Enough preclinical studies are done with individual herbs or their derivatives, for example, curcumin, ashwagandha, guggulu, kutki, shatavari, brahmi, guduchi, amla, ginger, and arsenic trioxide.^{13,14,16–20,81,94,95,98} There are very few studies available with complex herbal formulations, for example, rasagenthi lehyam, Brahma rasayana, semecarpus lehyam, triphala, and other rasayanas.^{13,14,88,97,98,102,103} Some human clinical trials are under

way with curcumin, resveratrol, and flavopiridol, which show promising results. The National Center for Complementary and Alternative Medicine has recommended doing more case studies to determine the herbal efficacy and future clinical studies. More randomized clinical trials need to be done for the herbs and formulations containing multiple constituents.^{100,101}

Conclusion

Overall, this review provides a glimpse of the ayurvedic approach to cancer diagnosis and treatment. This review also attempts to reveal how these approaches can be employed in today's world. Cancers of the colon, lung, breast, and prostate are most prevalent in the Western world. The mortality and morbidity in India owing to all of these cancers is very low. For example, the incidence of prostate cancer is 50-fold less in India compared with the United States.¹ The cause of the lower incidence, mortality, and morbidity could be lifestyle and diet related; the question of whether it is due to ayurvedic principles leading to a better diet and lifestyle is difficult to pinpoint. Ayurvedic treatments are still followed by 75 to 80% of the rural population of India. As much as 70% of the Indian population is vegetarian, and this may also contribute to the lower incidence of cancer. It also, however, raises several questions about current treatment. Although current treatment tends to be highly focused at the molecular level, it is highly unfocused at the whole organism level, making it reductionist. Ayurvedic treatment of cancer is a holistic approach and is currently preferred. The new wave of "system biology" and "genome revolution" is expected to provide a holistic approach to the treatment of cancer. In spite of it, this approach tends to ignore the relationship between mind, body, and spirit. It is our hope that ayurveda can help fill this gap.

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