Cancer—an ayurvedic perspective

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Abstract

An integrated approach is needed to manage cancer using the growing body of knowledge gained through scientific developments. Thousands of herbal and traditional compounds are being screened worldwide to validate their use as anti-cancerous drugs. The science of Ayurveda is supposed to add a step on to the curative aspects of cancers that have resemblance with clinical entities of arbuda and granthi mentioned in Sushrutha samhita. Hence, an attempt is made in this review to discuss about the pathology and therapeutic management of various cancers described in Ayurveda. Review of literature on anticancer drugs of plant origin revealed identification of newer ayurvedic drugs that are not mentioned in the ancient texts. These new findings add up to ayurvedic science that has been developed through ages. In addition, details of experimental and clinical studies conducted on single and compound ayurvedic preparations for their anticancer efficacy strongly emphasize ayurvedic therapy as a scientifically driven one and not simply unconventional.

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1. Introduction

Cancer is one of the most dreaded diseases of the 20th century and spreading further with continuance and increasing incidence in 21st century. In the United States, as the leading cause of death, it accounts for 25% of all the deaths in humans presently. It is considered as an adversary of modernization and advanced pattern of socio-cultural life dominated by Western medicine. Multidisciplinary scientific investigations are making best efforts to combat this disease, but the sure-shot, perfect cure is yet to be brought into world medicine.

Recently, a greater emphasis has been given towards the researches on complementary and alternative medicine that deals with cancer management. Several studies have been conducted on herbs under a multitude of ethno botanical grounds. For example, Hartwell [1–9] has collected data on about 3000 plants, those of which possess anticancer properties and subsequently been used as potent anticancer drugs [10]. Ayurveda, a traditional Indian medicine of plant drugs has been successful from very early times in using these natural drugs and preventing or suppressing various tumours using various lines of treatment.

The broad aim of this article is to provide a general outline on descriptions of cancers and their management from an ayurvedic practitioners’ perspective underlying its scientific principles involved in treating these conditions with the use of natural products. This article reviews the available literature regarding researches on anti-cancerous ayurvedic herbs and also includes a summary of treatment strategies for various cancers. It is written with an intention to raise awareness and encourage implementation of ayurvedic therapies for combating cancer and suggesting an integrated approach in tumour management and treatment.

1.1. Ayurvedic concept of cancer

Charaka [11] and Sushruta [12] samhitas, two well-known Ayurvedic classics, describe cancer as inflammatory or non-inflammatory swelling and mention them as either Granthi (minor neoplasm) or Arbuda (major neoplasm). Ayurvedic literature defines three body-control systems, viz., the nervous system (Vata or air), the venous system (Pitta or fire), and the arterial system (Kapha or water) which mutually coordinate to perform the normal function of the body. In benign neoplasm (Vinyaja, Pitajja or Kaphajja) one or two of the three bodily systems are out of control and is not too harmful because the body is still trying to coordinate among these systems. Malignant tumours (Tridosha) are very harmful because all the three major bodily

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systems lose mutual coordination and thus cannot prevent tissue damage, resulting in a deadly morbid condition [12].

1.2. Fundamental classification

Ayurvedic classification of neoplasm depends on various clinical symptoms in relation to Tridoshas.

Group I: Diseases that can be named as clear malignancy, which includes arhuda and yamnasa, e.g. mamsadhatu (melanoma) and karkarbadha (leukaemia), muhkarbuda (oral cancer), etc.

Group II: Diseases that can be considered as cancer, such as incurable ulcers with e.g. tridosaj galmas (abdominal tumours like carcinomas of the stomach and liver or lymphomas).

Group III: Diseases with the possibility of malignancy, e.g. Viatarpa (erysipelas), sudritya kamala (incurable jaundice) and nadh vrana (sinustis) [13,14].

1.3. Etiology

According to Sushruta, the fundamental cause of major neoplasm is the pathogens that affect all parts of the body. He called the sixth layer of the skin as ‘Rohini’, (epithelium) and pathogenic injuries to this layer in muscular tissues and blood vessels caused by lifestyle errors, unhealthy foods, poor hygiene and bad habits results in the derangement of doshas in a particular place were described as reasons for the non-infectious and non-supplicative nature of these abnormal growths [12,15].

Excess of water or fat in the corpus of the tumour and the stability and rigid confinement of the tissue damage, resulting in a deadly morbid condition [12].

According to Ayurvedic principles, the disease cannot be named on its own because it differs between persons in terms of illness, clinical presentation and also the treatment required [14]. Thus, pathogenesis in Ayurveda is explained on the basis of Tridoshas. Agni or Pitta, which is present in each and every cell, is responsible for digestion and metabolism in human body. The decrease in agni is inversely proportional to the related tissue and therefore in arhuda, the decreased state of bhatwagni (deranged metabolism) will result in excessive tissue growth.

Vata can be correlated with the anabolic phase of growth whereas kapha to the catabolic phase. Cancer originates due to a metabolic crisis, i.e. aggravation of vata forces and suppression of kapha forces, both interacting with one another resulting in proliferation. However, the abnormal cancerous growth at a specific organ (Ekadesavriddhi) is managed by compensation from other parts of the body (Ekaprasaraniyak-Shaya), e.g. body weight loss (cachexia) [17]. Sushruta has proposed six stages in the pathogenesis of all diseases but his concept suits more to the pathology of the tumour than pathogenesis itself:

1. Sanchaya: early stages of localized neoplastic changes.
2. Prakopa: transformation of primary growths into metastatic tumours.
5. Vyukti: clinical signs and symptoms are expressed.
6. Bhrada: the stage where differentiation of growth occurs on the basis of histopathology [17].

2. Cancer therapy—a practical dilemma

Any practical solution in combating this dreadful disease is of paramount importance. An alternative solution to western medicine embodied with severe side effects is the use of medicinal plant preparations to arrest the insidious nature of the disease. Many herbs have been evaluated in clinical studies and are currently being investigated phytochemically to understand their tumouricidal actions against various cancers. Thus, cancer patients who already got crippled with this disease, further burdened by drug-induced toxic side effects have now turned to seek help from the complementary and alternative medicine hoping for a better cure. Ayurvedic therapy was found to be able to cure these chronic diseases better, which were previously not amenable to treatment by western medical practices. This traditional Indian medicine with its evolution through centuries has always fascinated practitioners and researchers for its applications
in cancer treatment on a scientifically proven research background.

2.1. Principles of ayurvedic treatment

Abuse of nature’s law upsets the human system and ends up in disease like cancer. It is again the nature, the foremost physician who brings the cure. The Ayurvedic system of medicine was well founded on the basic principles of nature and its elements after a careful and thorough study of human physiology. This is the first system to emphasize health as the perfect state of physical, psychological, social and spiritual component of a human being.

The therapeutic approach of Ayurveda has been divided into four categories as Prakritishhatra chikitsa (health maintenance), Rasayana chikitsa (spiritual approach), Astanga sangraha (multi-systemic therapy) and Naishthiki chikitsa (disease cure) [18].

Finding the cause of an illness is the basic goal of ayurvedic therapy. It classifies disease development into six stages that include aggravation, accumulation, overflow, re-location, build-up in a new location, and manifestation into a recognizable disease. Ayurvedic physicians can diagnose an illness at even initial stages of body imbalance and their therapeutic approach maintains a balance by supplying deficient substances as well as reducing the excessive ones. Surgery is considered only for advanced cases.

2.2. Ayurvedic texts about cancer treatment

During the 7th century BC, Atreya and Dhanwantari used herbal medicines for treating the early stages of cancer and surgery in advanced cases. In the 8th century AD, Vagbhata, a Buddhist physician composed two texts: Astanga Hridaya [19] and Astanga Sangraha [20] where new methods for cancer treatment were introduced. Other Ayurvedic texts of internal medicine, viz., Chakradatta [21] composed by Chakrapani (10th century AD), the Sarangadhara Samhita [22] by Sarangadhara (14th century AD), the Bhavaprakasha Samhita [23] by Bhavamisra (15th century AD), the Satmya Darpan Samhita by Viswanath (16th century AD), the Vaisaiya Ramabali by Binoda Lala Sen Gupta (18th century AD), the Rasatarangini by Sadananda Sharma (19th century AD), etc. explain numerous remedies to treat internal and external neoplasms.

2.3. Treatment modalities

Sodhana chikitsa (purification process), which eliminates vitiated dosha, have been primarily used for medical management of cancer. When both internal and external medications were given then it is called as panchakarma chikitsa. The other type of curative therapy is called somana chikitsa, which pacifies dosha and gradually relieves the disease. However, this treatment is prescribed only to weaker patients for whom sodana chikitsa is contraindicated. In Rasayana prayoga (immunotherapy), certain poisonous plants, mercury like metals and animal products were rendered non-toxic and harmless by the use of alchemy and are used as rejuvenating drugs. Other methods of treatment include, dhathvagni chikitsa (correction of metabolic defects), vyadhrajanyaka chikitsa (specific anti-cancerous drugs) and lakshana chikitsa (symptomatic treatment) [24].

When medical treatment practices fail, then the case was left to surgeons. Surgical cancer management in Ayurveda include the principles of fomentation by means of external application, cleansing by internal medication, treatment to liquefy the contents of the swelling, opening the tumour surgically for evacuation of its contents, cauterisation to avoid recurrence and post-operative care for healing the wound [15].

Cauterisation with alkalis and acids and other surgical procedures were performed with herbal and mineral medicines. Arshuda is extracted completely from its deep root seat and cauterisation done to destroy any of the remaining cell particles [24].

2.4. Classical drugs claimed in ayurvedic texts

Traditional line of treatment: Traditional methods employed in treatment of various cancers were given in Table 1. In addition to these traditional methods, various herbal combinations mentioned in Ayurvedic texts are listed in Table 2.

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The main objective of these tables is to support the physicians and researchers to utilize these traditional methods as well as herbal drugs for an effective cancer treatment.

2.5. Scientific principles of Ayurvedic anticancer drugs

Herbal decoctions consisting of multiple herbs each possessing tremendous potential for a cancer cure are commonly used in Ayurveda. These formulations are reported to work on multiple biochemical pathways and are capable of influencing several organ systems simultaneously. The benefit of an herbal decoction is that it can nourish the body as a whole by supporting various organ systems [25]. Many of the herbs mentioned below have scientifically-proven anti-cancerous properties and are used for the treatment of various cancers.

2.6. Andrographis paniculata

The extract and isolated diterpenes (andrographiside and neoandrographolide) from this plant are proved to be beneficial against tumourigenesis by their anti-liperoxidative action and by enhanced carcinogen detoxification action [26–29].

2.7. Annona atemoya/muricata

Bullatacin, an acetogenin isolated from the fruit of Annona atemoya, induces apoptosis, preceded by chromatin margination and tumour cells condensation [30]. Several
Table 1
Classical treatment protocols for various tumours in Ayurveda

<table>
<thead>
<tr>
<th>Type of tumour</th>
<th>Tumour subtypes</th>
<th>Classical treatment procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaphaja arbuda</td>
<td>Vatika grhanta</td>
<td>Multani mitti paste was used as an external remedy [12]</td>
</tr>
<tr>
<td></td>
<td>Pittika grhanta</td>
<td>The paste of Soymida febrifuga, Capparis sepiaria, and Sulphur was used for local application [12]</td>
</tr>
<tr>
<td></td>
<td>Kapaja grhanta</td>
<td>Paste of Pongamia glabra and Embelia ribes was applied exterally by mixing them with honey. Oil from Pongamia glabra was used for internal administration [65]</td>
</tr>
</tbody>
</table>

Table 2
List of herbs commonly used in ayurvedic anticancer treatment

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the herb</th>
<th>Method and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vitis vinifera</td>
<td>The mixture of Terminalia chebula, grape juice and sugar cane juice has been used [5]. Reversatrol, a natural product derivative from grape juice has been proved to possess cancer chemopreventive activity [66]</td>
</tr>
<tr>
<td>2</td>
<td>Baliospermum montanum</td>
<td>The paste comprising of Baliospermum montanum, Plumbago zeylanica, Euphorbia neriifolia, Calotropis procera, jaggery, Sonneratia caseolaris and sugar Jaggery paste over the tumors [12]</td>
</tr>
<tr>
<td>3</td>
<td>Madhuca indica</td>
<td>This paste is prepared from the barks of Madhuca indica, Syzygium cumini, and Terminalia arjuna and is used for external application [16]</td>
</tr>
<tr>
<td>4</td>
<td>Pandanus odorattanum</td>
<td>A paste of Pandanus odorattanum with sugar was applied externally [12]</td>
</tr>
<tr>
<td>5</td>
<td>Pterospermum acerifolium</td>
<td>The flowers of Pterospermum acerifolium mixed with sugar to be applied locally</td>
</tr>
<tr>
<td>6</td>
<td>Raphanus sativus</td>
<td>Local application of Raphanus sativus powder paste with the radish ash was considered effective against kaphaja arbuda</td>
</tr>
<tr>
<td>7</td>
<td>Barleria prionitis</td>
<td>The Barleria prionitis oil prepared with whole plant is indicated for external application during acute stages of cyst in blood vessels [26]</td>
</tr>
<tr>
<td>8</td>
<td>Pongamia glabra</td>
<td>This paste made up of Pongamia glabra seeds, Raphanus sativus, Moringa oleifera, bud and mustard with sour buttermilk was applied locally for disintegrating cysts [20]</td>
</tr>
<tr>
<td>9</td>
<td>Amorphophallus campanulatus</td>
<td>The mature tuber is first barned and then mixed with butter and jaggery and applied for tumour destruction [12]</td>
</tr>
<tr>
<td>10</td>
<td>Ocimum indicum</td>
<td>The juice Ocimum indicum prescribed in treatment of granthi [12]</td>
</tr>
<tr>
<td>11</td>
<td>Basella rubra</td>
<td>The plant and leaves are ground with sour buttermilk with salt for preparing a poultice and indicated for arbuda [12]</td>
</tr>
<tr>
<td>12</td>
<td>Flacourtia romantchi</td>
<td>The paste of Flacourtia romantchi, Cassia fistula, Capparis sepiaria, is recommended for kaphaja tumours [12]</td>
</tr>
<tr>
<td>13</td>
<td>Moringa oleifera</td>
<td>The paste of Moringa oleifera seeds, Solanum xanthocarpum, Sinapis dichotoma, Holarrhena antidysenterica and Nurrus oleifer leaves prepared with buttermilk is used for arbuda tumours [23]</td>
</tr>
<tr>
<td>14</td>
<td>Ficus bengalensis</td>
<td>Application of mixture of Ficus bengalensis and Sauarea lappa partly tumour growth on bone [23]</td>
</tr>
<tr>
<td>15</td>
<td>Curcuma domestica</td>
<td>The Curcuma domestica powder in combination with Symplex racemosa, Syzygium cumini, is mixed with honey and this is used as an external remedy [23]</td>
</tr>
</tbody>
</table>
other annonaceous acetogenins, e.g. murricas A–G, muri-
catetocin A and B, longifolican, corosolin, and corosolone
are also showed to be significantly selective in bringing in
vitro cytotoxocities to tumour cells [31].

2.8. Phyllanthus niruri/amuru

An aqueous extract of P. amarus increases the life span of
the tumour bearing rats and normalizes γ-glutamyl transpep-
tidase activity [32]. It plays a major role in disruption of
HBsAg mRNA transcription and post-transcription which
could be beneficial against viral carcinogenesis [33].

2.9. Piper longum

Piperine, an active alkaloid extracted from this plant has
been used as an ingredient of ayurvedic anticancer formul-
ations because of its anti-oxidative potency in both in vitro
and in vivo conditions [34].

2.10. Podophyllum hexandrum linn. (Podophyllin)

It is a powerful anticancer drug against various cancers for
example, sarcomas, adenocarcinoma and melanoma. Podophyllin
and its active principle, podophyllotoxin are known for their
cytotoxic effect by virtue of their properties of mitotic in-
hibition, nuclear fragmentation, impaired spindle formation
and they are also found to be karyoplasts. The mechanism
of action has been suggested as necrosis and is a direct con-
sequence of its cytotoxic effect on tumour tissues. These
derivatives have been analysed in cancer chemotherapeutic
studies and the methods of preparation of these compounds
are patented [10].

In recent days, chemically modified podophyllotoxins are
widely used in cancer therapeutic. VP-16 (etoposide), a
podophyllotoxin derivative has been tested against in vitro
and in vivo cancer cells and been used against hepatic can-
cers for more than a decade [35]. It has proved its efficacy
in combination with etopubic in phase II studies [36,37].
By this combination therapy at least 3% of the patients had
complete cure and 36% had partial response. P-glycoprotein,
a drug efflux pump, seems to be less effective in reducing
VP-16 concentration in cancer cell lines and hence this drug
proves to be more efficient in these cells [38]. It is also safe
even above therapeutic dosage without much toxic effects
[39].

2.11. Tinospora cordifolia

The active principles from T. cordifolia enhance host
immunosuppression and hence could be a drug choice for
various cancers.

2.12. Semecarpus anacardium

In Ayurveda classics, numerous references are available
on the anticancer properties of Semecarpus anacardium
nuts [43]. An extensive review describes the phytochemical
and pharmacological properties of S. anacardium [44]. The
chloroform extract of S. anacardium nut possess antinmun
action with increased life span against leukaemia, melanoma
and glioma [45,46]. The milk extract of S. anacardium
produces regression of hepatocarcinoma by stimulating
host immune system [47] and normalizing tumour markers
including alpha-fetoprotein levels [48,49]. This prepara-
tion stabilizes the lysosomes, and normalizes glycoprotein
and mineral content in the body during cancer progression
[50,51]. It also corrects hypoglycaemia [52] and controls
abnormal lipid peroxidation [53] by the maintenance of an-
tioxidant defense status [54]. In the microsomes, it acts as
a bifunctional inducer of both phase I and II biotransforma-
tion enzymes and prevents tumour initiation by preventing
carcinogen activation [55,56]. Histologically, on treatment
with the S. anacardium extract to hepatocarcinoma animals,
the liver sections showed almost a normal architecture. The
nodules become completely regressed and further cell necro-
sis was prevented [57]. Anacartin forte, another preparation
from S. anacardium has been used for several decades as an
anticancer drug since it is giving health improvement with
alleviation or disappearance of troublesome symptoms. It
provides clinical benefit with an extension of survival time
in various cancers including oesophageal, chronic myeloid
leukaemia, urinary bladder and liver cancer [58]. Another
Ayurvedic drug containing S. anacardium, Amara rohitaka,
Glycyrrhiza glabra and copper powder were reported to
inhibit breast tumour development in mice by significantly
extending the survival period. This drug was also found to
be efficient in clinical trials [13].

Ayurvedic herbs, which are widely used and scientifi-
cally proven of their anticancer properties, are presented in
Table 3. Smit et al. [59] have also elaborately listed
ayurvedic herbal drugs with anticancer activity. Some of
these herbs are shown to enhance the therapeutic efficacy
and/or reduce the toxicity of anticancer drugs used in
chemotherapy. Also few of them possess radiosensitising ef-
fect too (see Table 4). Pharmacological details of ayurvedic
herbs like therapeutic dosage, side effects, and comments
about safety and herb-drug interactions were given in
Table 5.

3. Potential benefits of Ayurveda during
Cancer cachexia

Cancer cachexia is a common clinical problem that sub-
stantially impacts upon the quality of life and survival of
Table 3
Scientific evidence on herbs used in Ayurveda proven to have anticancer property

<table>
<thead>
<tr>
<th>Name of the herb</th>
<th>Indications</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrus precatorius</td>
<td>Yoshida sarcoma (rat) Fibrosarcoma (mouse) Ascites tumour cells</td>
<td>Subbarody and Sirc [67]</td>
</tr>
<tr>
<td>Allotica lehneek</td>
<td>Sarcoma 180 (mouse)</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Allium sativum</td>
<td>Sarcoma (rat)</td>
<td>Hu et al. [69]</td>
</tr>
<tr>
<td>Aloe vera</td>
<td>Yoshida AH-130 ascite hepatoma (pleural tumour) human neuroectodermal tumours</td>
<td>Corri et al. [70], Pecore et al. [71]</td>
</tr>
<tr>
<td>Alstonia scholaris</td>
<td>HSI human sarcoma benzo[a]pyrene induced forestomach carcinoma</td>
<td>Dhar et al. [68], Jagtia et al. [72]</td>
</tr>
<tr>
<td>Amaranth rohitua</td>
<td>Leukaemia</td>
<td>Prasad and Deshpande [73], Rabi and Gupta [74]</td>
</tr>
<tr>
<td>Anancardium occidentale</td>
<td>Hepatoma 120</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Asparagus racemosus</td>
<td>Human epidermol carcinoma</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Bacopa monniera</td>
<td>Walker carcinocarcina 256</td>
<td>Bhakuni et al. [75]</td>
</tr>
<tr>
<td>Berberis aristata</td>
<td>Human epidermal carcinoma of the nasopharynx X-irradiation induced carcinogenesis</td>
<td>Bhakuni et al. [75], Anis et al. [76]</td>
</tr>
<tr>
<td>Boscia serrata</td>
<td>Human epidermal carcinoma of the nasopharynx Lewisia and brain tumours</td>
<td>Hostanska et al. [77]</td>
</tr>
<tr>
<td>Calotropis gigantea</td>
<td>Human epidermal carcinoma of the nasopharynx</td>
<td>Bhakuni et al. [75], Dhar et al. [68]</td>
</tr>
<tr>
<td>Curcuma longra</td>
<td>Fibrosoarcoma Preclinical and clinical trials review</td>
<td>Sengarth and Premalatha [78]</td>
</tr>
<tr>
<td>Datura metel</td>
<td>Human epidermal carcinoma of the nasopharynx</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Erythrina suberosa</td>
<td>SARCOMA 180</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Euphorbia hirta</td>
<td>Freund virus leukaemia</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Gynandropis pentaphylla</td>
<td>Hepatoma 120</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Heliotropium indicum</td>
<td>P-388 lymphocytic leukaemia</td>
<td>Pal et al. [80]</td>
</tr>
<tr>
<td>Hygrophaea spinosa</td>
<td>Dalen’s lymphoma</td>
<td>Mazumde et al. [82]</td>
</tr>
<tr>
<td>Isorea undulata</td>
<td>P-388 lymphocytic leukaemia</td>
<td>Dhar et al. [83]</td>
</tr>
<tr>
<td>Jasminum indica</td>
<td>Human epidermol carcinoma of the nasopharynx</td>
<td>Dhar et al. [83]</td>
</tr>
<tr>
<td>Leptis cycloidea</td>
<td>Schwartz leukaemia</td>
<td>Bhakuni et al. [84]</td>
</tr>
<tr>
<td>Melia azedarach</td>
<td>Walker carcinocarcina 256</td>
<td>Bhakuni et al. [75]</td>
</tr>
<tr>
<td>Morinda citriflua</td>
<td>Human epidermol lymphocytic leukaemia Skin papillomagenesis</td>
<td>Dhar et al. [83]</td>
</tr>
<tr>
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<td>Erlich ascites carcinoma</td>
<td>Pal et al. [80]</td>
</tr>
<tr>
<td>Nigella sativa</td>
<td>Lewis lung carcinoma Colon cancer</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Ocimum sanctum</td>
<td>Skin and liver tumours</td>
<td>Dubey et al. [87]</td>
</tr>
<tr>
<td>Parthena feroxia</td>
<td>Human epidermol carcinoma of the nasopharynx</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Pterocarpus kurma</td>
<td>Hepatic cancers</td>
<td>Dhar et al. [68]</td>
</tr>
<tr>
<td>Plumbago zeylanica</td>
<td>Hepatoma</td>
<td>Parimala and Sachdanandam [88]</td>
</tr>
<tr>
<td>Rubia cordifolia</td>
<td>P-388, L-1210, B-16 melanoma, colon 388, Lewis lung carcinomas, mammary carcinoma</td>
<td>Itojima et al. [89]</td>
</tr>
<tr>
<td>Zanthox zittica</td>
<td>Cytostatic against various tumours</td>
<td>Melado et al. [90]</td>
</tr>
<tr>
<td>Vinca rosea</td>
<td>P-1534, carcinoma of the breast, cervix, kidney, lung and ovary</td>
<td>Rastogi and Mehrotra [91]</td>
</tr>
<tr>
<td>Withania somnifera</td>
<td>Various tumours</td>
<td>Dhar et al. [68]</td>
</tr>
</tbody>
</table>

cancer patients. The pathophysiology of this syndrome implicates tumour induced metabolic changes and immune responses. Clinical manifestations include anorexia, chronic nausea and change in body image. Among several potential benefits of ayurvedic medicine, relief from cancer cachexia is especially valuable. Ayurvedic herbs used in cancer therapy results not only in total healing, but also reduces the side effects and cancer associated complications. It also avoids the need for supplemental therapy to manage cancer cachexia. Each herbal product contains multiple active principles that may operate synergistically, producing therapeutic benefits and lowering the risks on adverse effects. The anorexia or weight loss could be effectively managed by Withania somnifera, Sida cordifolia, Asparagus


and increasing the appetite. These herbs might stimulate malnutrition, fatigue and sensation of well-being which are common in cancer patients resulting in loss of appetite.

**Table 4**

**Therapeutic enhancement potential of ayurvedic herbs on cancer chemotherapy/radiation**

<table>
<thead>
<tr>
<th>Name of the herb</th>
<th>Chemotherapy/ayurvedic herb intervention studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alstonia scholaris</strong></td>
<td>Water-soluble derivative of garlic, S-allylmercaptocysteine (SAMC), inhibited proliferation and cell cycle progression in two human colon cancer cell lines, SW-480 and HT-29, similar to the effects of sulindac sulfide (SS), a well-known colon cancer chemopreventive agent. Co-administration of SS with SAMC enhanced the growth inhibitory and apoptotic effects of SS, suggesting the usefulness of SAMC alone or in combination with SS or other chemopreventive agents [92]. Additionally, thymoquinone (TQ), the main constituent of the extract, showed significant antitumour and radiosensitising effects in HeLa and KB cells, followed by HL60, MCF7, and HepG2 cells. In vivo studies, with Ehrlich ascites carcinoma bearing mice the pre-treatment of extract caused increased life span of animals when compared with untreated irradiated group [95]. The combination treatment of <em>Alstonia scholaris</em> extract with cyclophosphamide was also found to be most effective against Ehrlich ascites carcinoma as it caused the highest tumour regression and enhanced the mean and average survival time when compared with cyclophosphamide alone treated group [96].</td>
</tr>
<tr>
<td><strong>Curcuma longa</strong></td>
<td>When radiation and curcuma were applied together as synergetic therapy, curcuma showed a radiation sensitising effect in HeLa, K-562 and IM-9 cell lines [97]. Curcumin, the active constituent from <em>Curcuma longa</em> also enhances the anticancer potential of Cisplatin and reduces its nephrotoxicity in fibrosarcoma bearing rats [78]. Furthermore, mice treated with ifosfamide in combination with TQ showed less body weight loss and mortality rate compared to IFO single therapy [100].</td>
</tr>
<tr>
<td><strong>Heliotropium indicum</strong></td>
<td>In a randomised double-blinded clinical trial, comparing mild soap and aloe vera gel against incidence of radiation therapy induced skin reactions, the median time of five weeks was taken to show any skin changes in the soap/soap treatment versus three weeks in the soap only treatment. The protective effect of adding soap to the soap regimen increases during long time radiation exposure [93]. In another clinical trial involving patients with advanced solid tumours, for whom no other standard effective therapy was available, combination of pinical indole melanotic (MLT) plus Aloe vera extracts produced some therapeutic benefits, at least in terms of stabilisation of disease and survival when compared to MLT alone treatment [94].</td>
</tr>
<tr>
<td><strong>Morinda officinalis</strong></td>
<td>Pre-treatment with the leaf extract of <em>M. officinalis</em> exhibits significant radiation protection to the bone marrow chromosomes in mice and this could be useful to overcome side effects of radiation therapy [99]. Further, in mice bearing Ehrlich ascites carcinoma, thymoquinone (TQ), the main constituent of the <em>Nigella sativa</em> oil, significantly enhanced the therapeutic efficacy of ifosfamide by improving its antitumour effect and reducing its nephrotoxicity. Furthermore, mice treated with ifosfamide in combination with TQ showed less body weight loss and mortality rate compared to IFO single therapy [100].</td>
</tr>
<tr>
<td><strong>Nigella sativa</strong></td>
<td>In mice bearing Ehrlich ascites carcinoma, thymoquinone (TQ), the main constituent of the <em>Nigella sativa</em> oil, significantly enhanced the therapeutic efficacy of ifosfamide by improving its antitumour effect and reducing its nephrotoxicity. Furthermore, mice treated with ifosfamide in combination with TQ showed less body weight loss and mortality rate compared to IFO single therapy [100].</td>
</tr>
<tr>
<td><strong>Ocimum sanctum</strong></td>
<td><em>Ocimum sanctum</em> has shown some improvement against skin melanoma and ovarian carcinoma [98]. Furthermore, mice treated with ifosfamide in combination with TQ showed less body weight loss and mortality rate compared to IFO single therapy [100].</td>
</tr>
<tr>
<td><strong>Taxus buccata</strong></td>
<td>In a Phase II study, the triplet regimen based on taxol (active constituent of <em>Taxus baccata</em>), also reduces cyclophosphamide induced myelosuppression and leucopenia can be useful in combination with SS or other chemopreventive agents [92]. The combination treatment of <em>Alstonia scholaris</em> extract with cyclophosphamide was also found to be most effective against Ehrlich ascites carcinoma as it caused the highest tumour regression and enhanced the mean and average survival time when compared with cyclophosphamide alone treated group [96].</td>
</tr>
<tr>
<td><strong>Withania somnifera</strong></td>
<td><em>W. somnifera</em> when administered for 4 days before paclitaxel treatment and continued for 12 days caused significant reversal of neutropenia of paclitaxel in mice. It can be used as an adjuvant during cancer chemotherapy for the prevention of bone marrow depression associated with anticancer drugs [105]. The active constituent, withaferin A isolated from the extract showed significant antitumour and radiosensitising effects in experimental tumours in vivo, without any noticeable systemic toxicity [106]. In Ehrlich ascites carcinoma mice, the extract showed dose dependent inhibition on tumour growth and increased the survival rate. Combination of radiation therapy with extract increased tumour cure and tumour-free survival [107]. It also reduces cyclophosphamide induced myelosuppression and leukopenia can be useful in combination chemotherapy [108,109].</td>
</tr>
<tr>
<td>Name of the herb</td>
<td>Therapeutic dose</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Abrus precatorius</td>
<td>Leaf decoction: 56–112 ml, root powder: 0.5–1 g</td>
</tr>
<tr>
<td>Allium sativum</td>
<td>2–5 g per day, solid extract: 0.3–1 g, oil: 0.03–0.12 ml t.i.d.</td>
</tr>
<tr>
<td>Aloe vera</td>
<td>Extract: 10–20 ml, powder: 0.05–0.2 g</td>
</tr>
<tr>
<td>Anacardium occidentale</td>
<td>Liquid extract: 4–8 ml, powder: 1–3 g</td>
</tr>
<tr>
<td>Annona squamosa</td>
<td>Leaf: 2–4 g, stem: 1–4 g, t.i.d., andrographolide: 4–8 mg</td>
</tr>
<tr>
<td>Andrographis paniculata</td>
<td>Powder: 1.5–6 g, juice of leaves and stem: 1–4 ml t.i.d., andrographolide: 4–8 mg</td>
</tr>
<tr>
<td>Asparagus racemosa</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Castor oil</td>
<td>5–10 g (0.4–0.5 g 8 ×) per day</td>
</tr>
<tr>
<td>Curcuma longa</td>
<td>Powdered bark: 2–3 g, liquid extract: 0.1–0.3 ml</td>
</tr>
<tr>
<td>Datura stramonium</td>
<td>Powder: 1–3 g</td>
</tr>
<tr>
<td>Erythrina variegata</td>
<td>Powder: 1–3 g</td>
</tr>
<tr>
<td>Ficus religiosa</td>
<td>Powdered bark: 2–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Gynandropis pentaphylla</td>
<td>Seed powder: 2–8 g, liquid extract: 40–50 ml</td>
</tr>
<tr>
<td>Hyoscyamus niger</td>
<td>Powder: 1.5–2 g, liquid extract: 0.2–0.3 ml t.i.d.</td>
</tr>
<tr>
<td>Ilex vomitoria</td>
<td>Powder: 1–3 g</td>
</tr>
<tr>
<td>Jatropha curcas</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Juniperus communis</td>
<td>Powder: 1–3 g</td>
</tr>
<tr>
<td>Luffa cylindrica</td>
<td>Seed powder: 2–8 g, liquid extract: 40–50 ml</td>
</tr>
<tr>
<td>Melia azedarach</td>
<td>Powder: 1–3 g</td>
</tr>
<tr>
<td>Nerium indicum</td>
<td>Powdered bark: 2–3 g</td>
</tr>
<tr>
<td>Nigella sativa</td>
<td>Leaf: 0.03–0.12 ml, powder: 0.05–0.2 g</td>
</tr>
<tr>
<td>Orostachys i_AGUS</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Panax ginseng</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Poria cocos</td>
<td>Powder: 1–3 g</td>
</tr>
<tr>
<td>Psidium guajava</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Quercus ilex</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Rhododendron ponticum</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Salvia miltiorrhiza</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Scutellaria baicalensis</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Stemonatostemon</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Tanacetum parthenium</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Theobroma cacao</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Thymus vulgaris</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Triticum aestivum</td>
<td>Powdered grain: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Withania somnifera</td>
<td>Powdered bark: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
<tr>
<td>Zingiber officinale</td>
<td>Powdered root: 1–3 g, liquid extract: 60–120 ml</td>
</tr>
</tbody>
</table>
Table 5 (Continued)

<table>
<thead>
<tr>
<th>Name of the herb</th>
<th>Therapeutic dose</th>
<th>Safety/duration/tonic dose</th>
<th>Side effects/contraindications</th>
<th>Interactions with other herbs/drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocimum sanctum</td>
<td>1–3 g, leaf infusion: 4–12 ml</td>
<td>Likely safe</td>
<td>May cause constipation at higher dosage for long term</td>
<td>None known</td>
</tr>
<tr>
<td>Paeonolia formosa</td>
<td>2–4 g, infusion: 12–24 ml, liquid extract: 56–112 ml</td>
<td>Non-toxic up to 2 g/kg in rats and mice</td>
<td>Insufficient information available</td>
<td>Insufficient information available</td>
</tr>
<tr>
<td>Phyllanthus niruri</td>
<td>Powder: 3–6 g</td>
<td>Safe</td>
<td>None reported</td>
<td>None reported</td>
</tr>
<tr>
<td>Picrorrhiza kuru</td>
<td>0.5–1 g</td>
<td>Low potential for toxicity</td>
<td>Nausea, diarrhoea, skin rash at high doses, contraindications in pregnancy</td>
<td>None known</td>
</tr>
<tr>
<td>Piper longum</td>
<td>0.5–1 g</td>
<td>Likely safe</td>
<td>May have contraceptive activity, avoid use during pregnancy and lactation</td>
<td>Piperine may interact with enzymatic drug biotransformation</td>
</tr>
<tr>
<td>Plumbago zeylanica</td>
<td>1–2 g</td>
<td>Plumbagin LD&lt;sub&gt;50&lt;/sub&gt; 10 mg/kg in mice, whole plant: 0.3 g/kg p.</td>
<td>None reported</td>
<td>None known</td>
</tr>
<tr>
<td>Raphanus sativus</td>
<td>15–23 g, liquid extract: 50–100 ml</td>
<td>Likely safe</td>
<td>Large amounts may cause irritation of GI mucous membrane</td>
<td>No interactions known to occur</td>
</tr>
<tr>
<td>Bubia cordifolia</td>
<td>Powder: 1–3 g, liquid extract: 56–112 ml</td>
<td>Generally recognized as safe</td>
<td>No adverse effects reported</td>
<td>None known</td>
</tr>
<tr>
<td>Semecarpus anacardium</td>
<td>Oil: 1–2 drops, fruit: 56–112 ml</td>
<td>Likely unsafe</td>
<td>Anacardic acid may be allergenic</td>
<td>No sufficient information available</td>
</tr>
<tr>
<td>Taxus brevica</td>
<td>0.5–1.5 g</td>
<td>Likely unsafe</td>
<td>No interactions known to occur</td>
<td>No interactions known to occur</td>
</tr>
<tr>
<td>Tinospora cordifolia</td>
<td>Powder: 1–3 g, liquid extract: 56–112 ml</td>
<td>Safe</td>
<td>Nausea</td>
<td>Excessive dose might inhibit vitamin B assimilation</td>
</tr>
<tr>
<td>Vinca rosea</td>
<td>Dosage depends on severity of the disease</td>
<td>Likely unsafe</td>
<td>GI upset, hepatotoxicity, nausea, vomiting, may also cause hypoglycemia</td>
<td>No interactions known to occur</td>
</tr>
<tr>
<td>Withania somnifera</td>
<td>Powder: 1–3 g, liquid extract: 56–112 ml</td>
<td>Safe</td>
<td>None reported</td>
<td>None known</td>
</tr>
<tr>
<td>Withania somnifera</td>
<td>0.15–0.3 g</td>
<td>Likely unsafe</td>
<td>None reported</td>
<td>May potentiate the action of barbiturates and benzodiazepines</td>
</tr>
</tbody>
</table>

somnifera, *Piper longum* can be directed to correct nausea and vomiting [60]. Among the above-mentioned herbs, *Withania somnifera* [61] and *Tinospora cordifolia* [42] are also proven to be powerful immunomodulants, which could increase body resistance power during cancer associated immunosuppression. Ayurvedic anticancer therapy includes recommendations for lifestyle and use of specific foods and herbs which are very helpful not only in preventing the progression of the disease but also makes the patients feel better and comfortable overcoming the symptoms. *Allium sativum* (garlic) could be helpful to manage pain and acne. *Bacopa monniera* strengthens mental faculties and helps to manage insomnia or sleeplessness due to stress [62]. An herbal combination of Withania somnifera, *Asparagus racemosas, 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. *Curcuma longa, Zingiber officinalis, Gynzyrrizha glabra, Terminalia chebula, Ocimum sanctum* and *Adhatoda vasica* are used to control cough and shortness of breathe especially for lung cancer patients [60]. Thus, ayurvedic therapeutic regimen rejuvenates the body tissues, tones up the systems and act as a tonic to the body against cancer cachexia. This kind of orientation toward total healing and health promotion makes ayurvedic treatment approach to cancer therapy promising.

4. Cancer therapy in Ayurveda—learning from the past, examining the present and advancing to the future

Because large population use ayurvedic medicine worldwide, there is an urgent need for additional, carefully conducted, high-quality intensive research to evaluate its efficacy and to develop this discipline to meet ever-new challenges of modern medicine in the field of oncology. The most stringent evaluation should take place with gold standards for clinical research—the randomised controlled clinical trial (RCT). Priority for research funding should be given to clinical investigations in Ayurveda involving well-designed studies with encouraging results especially for diseases like cancer to which conventional medicine...
has been shown to be less effective. Attention should be
given not only to the evaluation of safety and examination of
effectiveness in treatment strategy, but also to the con-
sideration of community practice settings, patient expecta-
tions, compliance and cost effectiveness. Standardization
and quality production of herbal products may allow us to
develop low cost therapies with reduced risk over pharma-
cueticals. In any case, studies on antitumor ayurvedic drugs
will be popular from the economy point of view because
cancer is becoming the major cause of death.

5. Conclusion and future directions

The clinical efficacy and extent of toxicity of numerous
antitumor agents are unknown and uncertain. For example,
research on majority of ayurvedic drugs is in the pre-clinical
phase or is not being actively pursued. Future research on
this topic would help to identify safe and effective anti-
cancer drugs and will further the exploration of their mech-
anism of action. Ayurvedic practitioners and researchers in
medical sciences can help to improve this medicine by in-
creasing their involvement and contribution. Case study is
the research design, which can form basis for future re-
search directions and can provide valuable contributions to
the medical field with minimal cost budgets. Case studies
have also been suggested by the NCCAM (National Cen-
ter for Complementary and Alternative Medicine, Bethesda,
USA) as a means to determine whether a complementary
antitumor therapy demonstrates potential efficacy against
particular cancer and whether clinical development of the
therapy should continue [63,64]. It is no longer an option
to ignore ayurvedic drugs or treat them as something un-
conventional from regular medical practices. The challenge
put before this medicine is to move forward carefully, using
both reasoning and wisdom.

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