Traditional Medicinal Plants and Their Therapeutic Potential Against Major Cancer Types

16

Kai Wei Lee, Siew Mooi Ching, Fan Kee Hoo, Vasudevan Ramachandran, and Mallappa Kumara Swamy

Abstract

Cancer is highly prevalent in the world and affects millions of people. Lung, prostate, colorectal, and breast cancers are the most commonly identified among cancer subjects and account for more than half of all cancer deaths. Surgery, chemotherapy, radiotherapy, and hormonal therapy are the typical treatments for cancer; however, the side effects of these treatments can be excessive and vary widely according to subject's health issues. At present, traditional herbal therapy can be used in conjunction with conventional treatments. The use of anticancer plants in medicine is becoming increasingly relevant, as they can reduce the side effects of medical treatments and improve patients' quality of life. Various traditional medical practices, including Chinese medicine, Ayurveda, Kampo, Unani, and Korean medicine, use herbs as major ingredients of their practice, and the effectiveness of these traditional medicines has been acknowledged after modern scientific testing in many cases. The records of traditional anticancer plants used

K. W. Lee · S. M. Ching (✉)
Department of Family Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Malaysia
e-mail: chingsiewmooi@gmail.com; sm_ching@upm.edu.my

F. K. Hoo
Department of Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

V. Ramachandran
Malaysian Research Institute on Ageing, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

M. K. Swamy
Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

Department of Biotechnology, Padmashree Institute of Management and Sciences, Bengaluru, India

M. S. Akhtar, M. K. Swamy (eds.), *Anticancer Plants: Natural Products and Biotechnological Implements*, https://doi.org/10.1007/978-981-10-8064-7_16

among various tribe, races, and nationalities are abundant. For instance, Liquorice root (*Glycyrrhiza glabra*) and snake-needle grass (*Oldenlandia diffusa*) served with hot water can help patients suffering from lung cancer. Likewise, *Astragalus membranaceus*, *Podophyllum hexandrum*, *Podophyllum petaton*, and *Arctium lappa* are commonly used all around the world to treat breast cancer. Colorectal cancer is treated with ashwagandha (*Withania somnifera*), garlic (*Allium sativum*), and ginger (*Zingiber officinale*). Therefore, there is an urgent need to document these potential ethnomedicinal plants in terms of anticancer drug discovery research. The scientific justification for these plants having a recuperative function in cancer must also be established. The main objective of this chapter is to provide an overview on anticancer plants used in traditional medicine to treat lung cancer, breast cancer, colorectal cancer, and prostate cancer.

Keywords
Cancer · Drugs · Ethnomedicine · Herbal therapy · Medicinal plants

16.1 Introduction

Cancer is one of the leading causes of morbidity and mortality worldwide, responsible for 8.8 million deaths in 2015 (WHO 2017). The most common causes of cancer death are lung cancer (1.69 million deaths), colorectal cancer (774,000 deaths), and breast cancer (571,000 deaths). Globally, nearly one in six deaths is due to some form of cancer, and while there were approximately 14 million new cases in 2012, the number of new cases is expected to rise by about 70% over the next 20 years (Ferlay et al. 2014). There are many types of cancer treatments available, such as surgery, radiation therapy, chemotherapy, immunotherapy, hormone therapy, and stem cell transplants. The primary goal of treatment is to remove or reduce the cancer or to considerably prolong life. However, persistent feelings of physical, emotional, or mental tiredness or exhaustion are common side effects of cancer treatments.

Traditional medicine has been practised over generations within various societies since well before the era of modern medicine; it is based on theories, beliefs, and indigenous experience and strives to maintain health and to treat illness (Swamy et al. 2011; Kumara et al. 2012; Akhtar et al. 2014a, b; Gezahegn et al. 2015; Swamy et al. 2016). Ayurveda, Siddha medicine, Yunani medicine, ancient Iranian medicine, Islamic medicine, traditional Chinese medicine, traditional Korean medicine, African Yoruba medicine, and traditional African medicine are some of the traditional methods followed to treat cancer. The core discipline or similarity among traditional medicine practices is herbalism, the use of plants and plant extracts for medicinal purposes (Swamy et al. 2017; Mohanty et al. 2017). This type of therapy is also widely adopted alongside conventional cancer treatments (Swamy and Sinniah 2015; Aung et al. 2017).

Currently, majority of the drugs available for the treatment of cancer are mainly derived from natural resources. Many of the approved anticancer drugs by The Food

and Drug Administration (FDA), USA, are either pure phytocompounds or their derivatives (Giddings and Newman 2013). A growing interest among researchers towards decoding prospective natural compounds from plants is mainly due to their lesser side effects and more specific to target sites with numerous mechanisms of action on cancer cells (Mishra and Tiwari 2011; Gali-Muhtasib et al. 2015; Aung et al. 2017). Considering the above facts, this chapter is aimed to update the information on the use of traditional medicinal plants and their curative properties against major cancer types such as lung, prostate, colorectal, and breast cancers.

16.2 Medicinal Plants as a Source of Anticancer Compounds

Medicinal plants have attracted global attention in recent years for their hidden therapeutic potentials (Swamy et al. 2017). Many plants have been investigated, and the parts to be used, along with processing and dosage instructions, have been richly recorded in the traditional medicine handbooks of many developing countries. The *Compendium of Materia Medica* is considered as the most complete and comprehensive medical book ever written in traditional Chinese medicine. It lists all types of the plants and the other items that were believed to have medicinal properties. Ayurvedic medicine and Unani are good examples of the oldest medical systems from ancient India, and those encouraged health promotion by means of herbal compounds and special diets. The African Yoruba and Islamic medical formulary described many preparations drawn from plants and other mineral sources. However, despite the rich ethnomedicinal knowledge that lies behind the traditional uses of these herbs, current scientific evidence to validate these medicinal claims remains scant (Swamy and Sinniah 2016; Mohanty et al. 2017). Continuing the quest for plant-based natural products is critical, however, and some medicinal plants have already been studied for their anticarcinogenic and antimicrobial activities. Several medicinal values imparted by plants are correlated to the occurrence of numerous bioactive compounds such as alkaloids, polyphenols, flavones, flavonoids, terpenoids, and many more (Arumugam et al. 2016; Swamy et al. 2017). Likewise, plants exhibiting anticancer and anticarcinogenic properties are reported to contain certain phytochemicals that have an inhibitory effect on human cells, including cancer cells; the most useful are, however, not toxic to humans. Multiple researchers have identified that most plants that have demonstrated anticancer properties are herbs that contain naturally occurring antioxidants such as polyphenols and brassinosteroids (Greenwell and Rahman 2015; Swamy et al. 2016; Mohanty et al. 2017; Aung et al. 2017). In the following section, these antioxidative compounds occurring in different plant species and their therapeutical potential against major cancer types are updated.

16.2.1 Plant Polyphenols

These are important components with chemopreventive and therapeutic properties that work against cancer. Polyphenol compounds include flavonoids, tannins, curcumin, stilbene resveratrol, and gallocatechins; these are all considered to be

anticancer compounds, inducing apoptosis in various cancer cell lines (Greenwell and Rahman 2015). Some of the major polyphenols and their anticancer activity against major cancers are discussed below.

16.2.1.1 Flavonoids

Flavonoids are secondary metabolites or plant pigments used for flower coloration and can thus be found ubiquitously in plants. Various plants that have been investigated for their anticancer properties, such as the fern species and plants used in traditional Chinese medicine, including litchi leaf (*Litchi chinensis*) and garlic (*Allium chinense*), are rich in flavonoid compounds. Litchi pericarp extracts demonstrated anticancer activity on breast cancer and hepatocellular carcinomas (Greenwell and Rahman 2015), while garlic contains quercetin and isorhamnetin, types of flavonoid that can control colon cancer cells and breast cancers (Lee et al. 2012; Del Follo-Martinez et al. 2013; Hu et al. 2015; Zeng et al. 2017). Parsley (*Petroselinum crispum, P. sativum*) seed extract kills breast cancer cells (Farshori et al. 2013), while black tea (*Camellia sinensis)* has been reported to contain theaflavin, thearubigins, and catechins that inhibit free radical generation (Balentine et al. 1997) and thus help to prevent chronic diseases such as cancer and cardiovascular problem (Łuczaj and Skrzydlewska 2005). Flavonoids are known to be physiologically active agents in plants and are thus becoming of high interest scientifically for their health benefits. Flavonoids manifest cytotoxicity on cancer cells and offer high free radical scavenging activity through intrinsic and extrinsic signalling pathways. They also inhibit and alter regulation of proteins and other agents that may contribute to the survival of cancer cells (Valko et al. 2006).

16.2.1.2 Tannins

Tannins, an astringent organic compound, are toxic to many microorganisms due to inhibition of oxidative phosphorylation (Scalbert 1991). It is responsible for the puckering feeling in the human mouth following the consumption of unripe fruits or tea (Vidal et al. 2004). Pomegranates (*Punica granatum*) have been widely studied for their potent antioxidants, which include ellegitannin, elegiac acid, and punicalagin, which are commonly known for their anti-proliferative and apoptotic effects on colon cancer cell lines (Seeram et al. 2005). Herbs such as cloves (*Syzygium aromaticum*) can also play important role in preventing and treating some cancers. Cervical, breast, prostate, and oesophageal cancer cells were killed within 24 h after the application of clove oil (Dwivedi et al. 2011). It was also found effective in treating lung cancer by means of in situ cell proliferation (Banerjee et al. 2006). Tarragon (*Artemisia dracunculus*) extract is indicated as cytotoxic to breast cancer though regulation of certain proteins that induce apoptosis (Obolskiy et al. 2011). Tarragon also contains potent compounds such as sakuranetin and 6-methoxycapilliarisin that appear to have anticancer effects on oesophageal cancer by inducing DNA damage in the cancerous cells (Hong and Ying 2015). Cumin (*Cuminum cyminum)* has been used since ancient times, and some studies have shown it to have a cytotoxic effect to colorectal cancer cell lines (Prakash and Gupta 2014; Al-Snafi 2016). Thyme (*Thymus vulgaris)* essential oil has been claimed to demonstrate cytotoxic activity

on head and neck squamous cell carcinomas by interrupting reproduction at the transcriptional level of cancer cells, with effects such as interfering in N-glycan biosynthesis and extracellular signal-regulated kinase 5 signalling (Sertel et al. 2011). Cinnamon (*Cinnamomum* sp.) is most commonly known as culinary spice, yet it is also used for its medicinal properties in treating gastrointestinal sickness. Cinnamon bark extract was evaluated for anticancer ability, and it was found to induce apoptosis in HepG2 cells (liver cancer cells) after 24 h at certain dosages (Varalakshmi et al. 2014). An extract of cinnamon, 2′-hydroxycinnamaldehyde, shows several antitumour effects on oral cancer cell lines; this is demonstrated by anti-proliferative activity of apoptotic cells and inhibition of tumour mass growth (Kim et al. 2010).

16.2.1.3 Curcumin

This compound is a yellow pigment produced by plants, mostly by those in the ginger family (Zingiberaceae). Curcumin has enormous potential in terms of cancer prevention and treatment, and numerous studies and reviews described it as a potent antioxidant and anti-inflammatory agent (Aggarwal et al. 2003; Agrawal and Mishra 2010). It inhibits biochemical activity, restraining overexpression of some signalling pathways and regulating the expression of tumour suppression genes (Creţu et al. 2012). Temu kunci, or galangal (*Boesenbergia pandurata*), is a rhizome generally used in cooking that can also be prepared to treat diarrhoea and mouth ulcers. It has been proven non-toxic to human skin fibroblast cells and offers protective effects against colon cancer (Kirana et al. 2007). Turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) are two plants that contain an abundance of curcumin and which have been investigated for their therapeutic properties. One piece of research, for example, showed that ethanolic extract of turmeric showed anti-melanoma activity against malignant melanomas (Danciu et al. 2015).

16.2.1.4 Stilbene Resveratrol

It is present in several dietary materials such as grapes (*Vitis vinifera*) (Burns et al. 2002). Stilbene compounds such as trans-astringin and trans-piceatannol are also found in wine, and these show potential in terms of anticancer chemopreventive activity (Waffo-Téguo et al. 2001). Ban-Zhi-Lian (*Bauhinia racemosa*) was also examined and found to have significant anticancer activity on lung cancer, ovarian cancer, prostate cancer, and breast cancer cell lines, as well as aiding the treatment of leukaemia. Extracts of this plant contain anthraquinone, saponins, terpenoids, and alkaloids that show 90–99% cell growth inhibitory activity on various human cancer cell lines (Mishra et al. 2013). Pirandai (*Cissus quadrangularis*) has been used to treat skin diseases; herbal extracts of pirandai showed significant anticancer activity on skin cancer cell lines, thanks to the release of cytochrome c, which induces apoptosis (Bhujade et al. 2013). Ethanolic extracts of pirandai, which contain various secondary metabolites such as phenols and tannins, demonstrated anticancer activity on breast cancer (Ruskin et al. 2014). Mugga (*Eucalyptus* sp.) has been traditionally used for a variety of medical purposes, including cancer treatment. One piece of research showed that this plant presented weak to moderate cytotoxicity to non-lymphoma tumour cell lines and potent anticancer activity to lymphoma tumour cell lines (Bardaweel et al. 2014).

16.2.1.5 Gallocatechins

Gallocatechins are found in green tea, redcurrants, gooseberries, and marrowfat peas. The consumption of these suggested reducing the risks of various cancers such as those of the bladder, prostate, and oesophagus (Greenwell and Rahman 2015). Tea is one of the most popular beverages in the world, and most of the cultures whose diets are rich in green tea have proportionately fewer cases of certain cancers (Sivakumar et al. 2010). Green tea (*Camellia sinensis* var. *assamica*) polyphenols, particularly the gallocatechins, are important antioxidants that offer chemopreventive effects against cancer (Takeo 2015). Another piece of research showed that consumption of green tea was closely related to a reduction in the risk of deaths due to cancer (Jankun et al. 1997). Redcurrant (*Ribes rubrum*) in freeze-dried form shows preventive functions in terms of many cancer cell lines; this is expressed through cell cycle arrest and the interruption of gene expressions of cell division enzymes (Lim 2012). The potent inhibition of cancer cell lines such as stomach, prostate, intestine, and breast cancer cell lines offers promising anti-proliferative protection against cancer cell lines (Boivin et al. 2007).

16.2.2 Brassinosteroids

These compounds are potent hormones that arise from naturally occurring compounds found in plants; these play a role in promoting high-growth activity and enhance resistance and tolerance to disease and stress. They are found at all young vegetative tissues throughout the plant kingdom (Bajguz and Tretyn 2003). Recently, these compounds were proven to inhibit cell growths in breast cancer cells without any side effects to non-tumour cell growth. This was achieved through interactions with the cell cycle machinery (Steigerová et al. 2010). Another study on the anti-angiogenic activity of brassinosteroids showed that they can react with human steroid receptors and produce novel combinations of activators and inhibitors to inhibit anti-genesis by reducing the mobility of tumours to prevent metastasis (Rárová et al. 2012). A key specification in anticancer treatments is for the agent not to be cytotoxic to normal cells and be cell specific to cancer cells. Another piece of research also found that brassinosteroids inhibited both breast and prostate cancer cell lines by arresting cancer cells in the G1 phase cell cycle and inducing apoptosis without affecting normal cell growth (Malíková et al. 2008).

16.3 Natural Anticancer Compounds and Pharmaceutical Industry: Current Status

Natural products have traditionally been important sources of pharmaceuticals. New technologies to produce synthetic chemistry products by conventional pharmaceutical industrial means have met with some drawbacks. The disadvantages of conventional medicine are that sickness often can't be completely treated, only temporary control can be offered as a result, and most importantly, patients with

cancer can't be cured by taking medication. To treat cancer, surgical treatments, radiotherapy, and chemotherapy are used. The benefit of these treatments is the removal of cancer cells; these are systemic treatments and are widely adopted. However, these treatments often cause traumatic effects, as well as being expensive, and they may shorten or risk the survival of the cancer patient in some cases. To date, there is no medical approach to completely cure cancer, and therefore the pharmaceutical industry has begun to pay attention to natural products to find new bioactive substances. In terms of cancer treatment, there are many benefits to traditional medicine. Many people believe that herb consumption is less toxic, with minimal side effects, although, of course, this depends on the herb being consumed. Traditional medicine treatments aim to enhance the patient's immune system and to inhibit the recurrence or metastasis of cancer cells. However, there is a large degree of uncertainty around herb-based medication; many new compounds isolated from natural products have only been tested in regional or local healing practices, and many are adopted without thorough testing or clinical evidence, with minimal or no industrial processing; few of these compounds or functional herbs are ever been registered and marketed (Fabricant and Farnsworth 2001).

Several notable examples of herbs that have been proven to control certain cancers effectively have been thoroughly studied, clinically attested, and are now processed in the pharmaceutical industry. These are kanglaite, Pacific yew, happy tree, and triphala. Kanglaite (*Coix lacryma-jobi*) is commonly known as Job's tear. Those have received significant attention in the global health market as the first drug derived from a traditional Chinese herbal remedy that has been shown to successfully control cancer cells and notably improving patient immune function. This herb was registered as KLT in China, the USA, and Russia. It is prepared in a fat emulsion formulation, and it is administered via intravenous injection and intraarterial perfusion. The injection of this herbal extract has been undertaken on more than 200,000 patients to treat cancer in China. Clinical trials on breast carcinomas, lung cancer, liver cancer, oesophageal cancer, pancreatic cancer, kidney cancer, gastric cancer, colorectal cancer, ovary cancer, and prostate cancer show improved therapeutic effects and evidence of prolongation of life (Normile 2003; Lu et al. 2008; Li et al. 2009; Zhu et al. 2009; Shan et al. 2012; Zhan et al. 2012).

A striking example among anticancer herbs is the Pacific yew (*Taxus brevifolia*). This plant contains the antitumour agent taxol, which was first isolated in 1971 (Wani and Taylor 1971). The plant is a potentially limited source that was already becoming scarce when its chemotherapeutic potential was realised. It was approved for medical use in 1993 (Fischer and Ganellin 2010). Large-scale production and commercialization have promoted plant extract production using a semi-synthetic pathway or attempt to use plant extracts from alternative species of *Taxus*, which can then be converted into taxol (Witherup et al. 1989). This compound was commercially developed by Bristol-Myer Squibb; taxol is the generic name, and the brand name for the commercial version is Paclitaxel. The chemotherapy drug paclitaxel (taxol) is used in breast, ovarian, and lung cancer treatments (McGuire et al. 1996; Sandler et al. 2006; Miller et al. 2007).

Happy tree (*Camptotheca acuminata*) is a tree native to China that is used as a cancer treatment in traditional Chinese medicine. It was discovered in 1966 as part of a systematic screening of natural products for anticancer drugs (Wall et al. 1966; Carte et al. 1990). Camptothecin was isolated from bark and stem of this tree, which showed remarkable anticancer activity in preliminary clinical trials (Potmesil and Pinedo 1994). Further clinical research found it to affect human malignancies such as colorectal and ovarian cancer (Shimada et al. 1993; Slichenmyer et al. 1993; Takimoto et al. 1998). Camptothecin is now manufactured by many pharmaceutical companies of India such as Brios Pharma, Altavista Phytochemicals Private Limited, and Green India Herbs.

Triphala, otherwise known as tree fruits, is an Ayurvedic herbal formula consisting of three plants: Amalaki (*Emblica officinalis*), Bibhitaki (*Terminalia bellirica*), and Haritaki (*Terminalia chebula*). The active compounds in triphala are gallic acid, chebulagic acid, and chebulinic acid (Naik et al. 2006; Gupta 2012). It is taken to promote internal cleansing in all stagnating conditions and to improve digestion; it is generally consumed as a food supplement rather than taken as a medication to treat cancer. Triphala is a product of the Himalaya Drug Company, India, and is sold solely for digestive care. In terms of clinical use, triphala aqueous extract has been tested for cytotoxic effects on many cancer cell lines, such as breast cancer (Sandhya et al. 2006); the anticancer activity of triphala appears to be part of a synergistic effect of the combination of plant extracts; each extract was also tested to see whether it induced apoptosis, had antimutagenic effects, or activated cell death programme on cancerous cells (Wongnoppavich et al. 2009). There is a great deal of research evidence to show that triphala can treat cancer *in vitro*; however, more clinical research is required before triphala can be considered as a treatment for cancers.

16.4 Traditional Medicinal Plants in the Treatment of Major Cancer Types

16.4.1 Lung Cancer

16.4.1.1 Astragalus (*Astragalus membranaceus*)

This is one of the most widely used herbs in traditional Chinese medicine; it is known in Mandarin as *Huangqi*. It is a general immune booster and thus helps to reduce the immune suppressing effects of chemotherapy, as well as enhance the effects of cisplatin and carboplatin during chemotherapy (Guo et al. 2012). Research has found astragalus to increase effectiveness of platinum-based chemotherapy on cancer patients with compromised immune systems as a result of said chemotherapy (McCulloch et al. 2006). The Chinese Materia Medica recommendations for astragalus doses are 9 to 15 g/day (used in combination with other herbs), and the prescription may vary according to the severity of the illness. Patients taking astragalus supplements experienced enhanced recovery times and improved survival rates due to the reduction in chemotherapy toxicity; this is therefore a promising

adjunctive treatment for cancer. This herb is revered for its ability to boost the immune system by promoting white blood cell count and by encouraging proliferation of antibodies to strengthen antiviral immunity (London 2010).

16.4.1.2 Adenophora (*Radix adenophorae*)

This is a Chinese herb "nan sha shen", also known as American silver to proot, which is used to nourish the yin. It is commonly used for the lungs, to clear up lung heat, dissolve phlegm, and relieve coughs (You Li 2010). According to traditional Chinese medicine, Adenophora is sweet, slightly bitter, and cold, and its main functions are to treat coughs, bronchitis, and pulmonary infections (Sahashi 2005). It is often used in herbal cough remedies for children (Liu 2009). Adenophora is considered safe and can be found in almost all herbal shops. The American herbal products association has given it a class 1 rating, means it can safely be consumed when used appropriately (Gardner and McGuffin 2013).

16.4.1.3 Liquorice Root (*Radix glycyrrhizae*)

It is known in Mandarin as "gancao". In Chinese medicine, it is commonly combined with other herbs in a single prescription to tone the lungs and spleen and to relieve coughs and shortness of breath (Wang et al. 2013). It can mitigate the effects of various foods, herbs, drugs, and chemical poisonings (Fiore et al. 2005). In decoction for lung relief, it is paired with Folium Mori "Sang ye" and other herbs, to moisturise the lungs (McNamara and Song 1995). It is clinically proven to accelerate mucus secretion and sooth lung inflammation (Aly et al. 2005). From a research perspective, a substance extracted from liquorice root, licochalcone A, has been shown to have antitumor activity in lung cancer (Shibata et al. 1991; Asl and Hosseinzadeh 2008).

16.4.1.4 Poria (*Wolfiporia extensa*)

This is known in Mandarin as "fu ling". It is actually a fungus whose filaments are stored and used as medicine. It has been used medicinally in China for long-term health care by consuming it on daily basis (McNamara and Song 1995). Traditional Chinese medicine believes this herb is sweet and tasteless in flavour and neutral in terms of properties. One of its main uses is to relieve choking coughs caused by phlegm (Wu and Fischer 1997). It has also been used in various herbal combinations to treat diarrhoea, kidney inflammation, and gastrointestinal tract bleeding (Huang 1998). Poria extract contains triterpene and polysaccharide fractions that have demonstrated anticancer action through the mechanism of down regulation of nuclear factor-kappa B activity and its signalling pathway, as well as having anti-angiogenesis properties and inducing apoptosis (Poucheret et al. 2006; De Silva et al. 2012). The cytotoxicity of poria in formulations against lung cancers has been proven efficient (Leem 2015).

16.4.1.5 Snake-Needle Grass (*Oldenlandia diffusa*)

This is known as "bai hua she she cao". This herb has demonstrated as anticancer and chemopreventative effects in both laboratory and animal studies (Wong et al.

1996; Song et al. 2004). The herb reduces lung metastasis when orally administered (Gupta et al. 2004). Studies reported anti-inflammatory effects through the reduced production of tumour necrosis factor alpha, interleukin-6, and prostaglandin-2, all of which are commonly over expressed in mesothelioma cancers (Yoshida et al. 1997; Gupta et al. 2004). Although several lab and animal studies have shown this herb to have anticancer effects, clinical investigation in humans has failed to produce similar evidence.

16.4.1.6 Asparagus Root (*Asparagus officinalis*)

Wild asparagus root is known as "tian men dong" in traditional Chinese medicine. It is used to relieve asthma, suppress coughing, and promote expectoration (Huang 1998). It is held to be sweet and bitter in flavour and cold in nature, nourishing the lungs and moistening dryness (McNamara and Song 1995). Though studies conducted on asparagus root to examine its biological effects have only been conducted on animals, the evidence so far shows anticancer activity against leukaemia and lung cancer by means of the inhibition of tumour necrosis factor alpha (Huang et al. 2008).

16.4.1.7 Jin Fu Kang

It is a blend of 12 herbal extracts formulated against lung cancer by researchers at the Shanghai University of Traditional Chinese Medicine, China. It has been shown that lung cancer patients who receive a combination of jin fu kang and chemotherapy survive at higher rates. It is also commonly used to improve blood circulation and alleviate pain (Liu et al. 2000). It contains Pueraria root, notopterygium, frankincense, myrrh, earthworm, salvia root, ligusticum root, white peony root, and wingless cockroach. The administration method involves 5-gram sachets, dissolved in lukewarm boiled water, and taken orally after a meal, one to two sachets each time, twice a day (McNamara and Song 1995). However, this medication is not suitable for pregnant women or patients with gastric ulcers or hypertension (Yang et al. 2009). It was developed at the Shanghai University of Traditional Chinese Medicine specifically for the treatment of lung cancer. The formula has been clinically tested for decades and was approved by the Chinese Drug Administration in 1999. Lung cancer patients undergoing chemotherapy who also take jin fu kang show increased survival rates when compared to those undertaking chemotherapy treatment alone (Liu and Sun 2007).

16.4.1.8 Yang Zheng Xiao Ji

It is a formulation of 14 herbs used to treat cancer in the traditional Chinese medicine. It contains extracts of *Radix astragali*, *Fructus ligus, Fructus ligustrilucidi*, *Radix ginseng*, *Ganoderma lucidum*, *Rhizome curcuma*, *Rhizoma atractylodes*, and *Hedyotis diffusa*. It is also used to improve the appetite and immune system. It has been found to restrain tumours from spreading through inhibiting cell adhesion and migration, and it has a marked effect on angiogenesis (Jiang et al. 2012). In combination with chemotherapy, it has been shown to increase survival rates and reduce side effects (Jiang et al. 2015).

16.4.2 Breast Cancer

16.4.2.1 Garlic (*Allium sativum*)

For many centuries, garlic has been used to treat a range of illnesses (Gupta et al. 2004). Garlic oil contains a sulphur-holding substance known as ajoene oil or allicin. This oil has been found to control cancer cell production. The anticancer activity of garlic is thus due to its high levels of organic sulphides and polysulphides. The mechanism behind the antitumour activity triggered by stimulating the lymphocytes and macrophages is that they kill cancerous cells and interfere with tumour cells' metabolism. The administration method involves taking 5–6 cloves of crushed garlic, around 5 g/day (Kapoor 2000). The crushed cloves should sit for at least 15 min to release the allinase enzyme before consumption (Shareef et al. 2016).

16.4.2.2 Purple Coneflower (*Echinacea* sp.)

This herb was used by native Americana to cure wounds and infections. It is processed into either comminute or powdered substances, to serve as a tea for oral use or packaged into solid dosage form. Then dry extract is extracted using ethanol and encapsulated into 170–470 mg capsules. In powder form, it is packed 250 mg/capsule (Gupta et al. 2004). This herb is also sometimes served as a liquid tincture (Barnes et al. 2005).

16.4.2.3 Burdock (*Arctium lappa*)

Burdock is a plant that is sometimes used as a food. The root, leaf, and seeds are also used to make medicine. It has been used to treat variety of ailments, including diabetes and hair loss, and it is said to kill germs and reduce fever. It is also used for high blood pressure and sometimes to increase the sex drive. In traditional European medicine, this herbal preparation can be comminute, powdered, made into a tincture, and used as a soft extract. A European powdered capsule contains 350 mg/capsule, and the dose for liquid extracts is 25–50 drops, 1–3 times/day. For tinctures, 50 drops, 1–3 times/day, are recommended. The dry extract dose is 1 g/day (Gupta et al. 2004). As an Ayurvedic medicine, 40 mg/tablet of powered burdock is served. Its roots are also used in therapeutic remedies (Poucheret et al. 2006).

16.4.2.4 Green Tea (*Camellia sinensis*)

The unfermented cut young dried leaves of *Camellia sinensis* are used to produce various types of teas. They contain less than 2% by weight of caffeine and are generally taken by mouth to improve mental alertness and thinking (Zaveri 2006). Herbal preparations can be either comminuted or powdered. Green tea is rich in flavonoid compounds and amino acids (Wang et al. 2000), and green tea is well documented in European herbal medicine as a remedy for sickness. In capsule form, each contains 250–465 mg, and 2 tablets/day are recommended (Gupta et al. 2004). However, population research suggests that drinking green tea is not linked to a reduced risk of breast cancer in Asian people, though green tea may have different protective effects in people depending on their genotypes. However, drinking green tea does seem to be linked with a reduced risk of breast cancer recurring (Wu et al. 2003; Zhang et al. 2007).

16.4.2.5 Ginseng (*Panax ginseng*)

Ginseng can refer to either white or red ginseng, and herbal preparations vary according to the type. In European herbal medicine, ginseng is powdered into 300 mg/capsule, with 2–3 capsule/day dosage (Lust 2014). For ginseng in dry extract, 15 ml of oral liquid is given once daily. Each 15 ml of oral liquid contains 140 mg of dry extract (Kapoor 2000). American ginseng is also listed as an ingredient in some soft drinks, and its oil and extracts are used in soap and cosmetics (Gupta et al. 2004). There is a little evidence in terms of clinical research to support ginseng treating breast cancer (Shin et al. 2000). However, research conducted in China suggests that patients treated with any form of ginseng maintained better psychological condition. Thus, it might be more appropriate to say it has benefits in terms of supporting and minimising damage from the cancer drug tamoxifen in treatment (Cui et al. 2006).

16.4.2.6 Ashwagandha (*Withania somnifera*)

This is a common herb in Ayurvedic medicine, and it is known as Indian ginseng. Traditionally, the berries and leaves are applied externally to tumours or tubercular swellings. The roots are powdered and mixed in milk and honey to treat burns and wounds. Extracts of Ashwagandha are taken as a supplement in 300–500 mg/tablets, 3 times/day (Kapoor 2000). Ashwagandha can also be taken as powder served with milk (Mishra et al. 2000).

16.4.2.7 Mahogany (*Dysoxylum binectariferum*)

This is used in Ayurvedic medicine for its anti-inflammatory and immune regulatory properties (Kapoor 2000). Several pieces of research have shown evidence of its potential in terms of anticancer activity (Cragg and Newman 2005; Jain et al. 2014). This plant contains the compounds required to act as a substitute for the synthetic flavopiridol medication used to control breast cancer (Kumara et al. 2012). The juice of mahogany is thus served as traditional medication to cure cancer (Kapoor 2000).

16.4.2.8 Bearberry (*Vaccinium macrocarpon*)

The fruits are edible and juiced for medicinal purpose by herbal practitioners. Bearberry tea is a traditional herbal treatment in northern Europe and Eurasia. It is served in traditional medicine to cure free radicle damage in the body and to prevent breast cancer. The most prominent function of bearberry juice is in treating urinary tract infections and kidney stones (Lust 2014).

16.4.3 Colorectal Cancer

16.4.3.1 *Aloe vera* (Synonym: *Aloe barbadensis*)

A. vera is an herbal remedy promoted as treating a variety of illness (Lust 2014). These two herbal remedies act together as a means to cleanse the colon and eliminate toxins which could accumulate in the digestive tract causing disease; they also function as an anti-inflammatory agent (Kapoor 2000).

16.4.3.2 Celandine (*Chelidonium majus*)

It is a member of poppy plant family. The parts that grow above the ground are used to make medicine(Lust 2014) and can be comminuted into a tea infusion or taken as around 1.2–3.6 g in a tincture with 45% ethanol or 2–4 ml of a 1:10 preparation three times/day (Kapoor 2000). Celandine has been used to treat scurvy and promote diuretic activity (Gilca et al. 2010; Dumbravă et al. 2008). This herb is also used to treat asthma (Vavrečková et al. 1996). Celandine extract can be used externally as eye drops in suitable organic solvents. It is also applied to the skin to treat bleeding wounds, swollen joints, and warts (Kapoor 2000).

16.4.3.3 Ginger (*Zingiber officinale*)

It is an Ayurvedic herb and used in many Indian dishes (Kapoor 2000). Inflammation markers that have been proved in clinical research to act as precursors to colon cancer can be reduced significantly by the consumption of ginger powder or ginger roots (Abdullah et al. 2010). A powerful anti-inflammatory, ginger soothes and heals the digestive tract (Stoilova et al. 2007). Based on research findings, ginger can decrease the level of inflammatory markers in the gut tissue; increased inflammation and chronic inflammation in the gut are highly associated with developing precancerous lesions or cancerous polyps (Abdullah et al. 2010), and thus ginger has been suggested as one of the best home remedies for the prevention of colon cancer.

16.4.3.4 Turmeric (*Curcuma longa*)

In Ayurvedic practices, this has been used as attempted treatment for a variety of internal disorders such as indigestion, throat infection, and the common cold (Kapoor 2000). Curcumin is the active ingredient in the turmeric, and research has demonstrated that when colon cancer cells are pre-exposed to curcumin and then treated with silymarin, the cells undergo a higher rate of cell death (Akram et al. 2010). Some herbalists use turmeric to prevent and treat colon cancer. There is no absolute administration of turmeric dosage to treat colorectal cancer, but the low cancer rate in India may be related to turmeric consumption in most people's diets (Potter et al. 1993; Mohandas and Desai 1998).

16.4.4 Prostate Cancer

16.4.4.1 Cannabis Oil (*Cannabis sativa*)

Cannabis is a plant that has been used for medicinal purposes for a many years. It is commonly known as marijuana, hemp, or cannabis (Lust 2014). Cannabis has many bioactive compounds; the cannabinoids have been identified as potential powerful natural cures for prostate cancer (Sarfaraz et al. 2005). Most prostate cancer patients have an inhibitor of DNA binding 1 (ID-1) gene that is the causal factor for the aggressive and uncontrolled multiplication of cancer cells (Ouyang et al. 2002). Scientifically, cannabinoids were found to inhibit the ID-1 gene and reduce the number of cancer cells. Cannabis is also helpful in reducing cancer-related side effects (Hermanson and Marnett 2011). However, some crude cannabis oils may be

hallucinogenic; therefore, the stalks and sterilised seeds of this plant should be used to produce hempseed oil, which is less hallucinogenic and without cannabinoids. This hemp oil is used to control inflammation and reduces neurological problems. The traditional medicine suggests consumption of 60 g or 60 ml/day for up to 90 days (Lust 2014). However, consumption of cannabis or hemp oil can lower the blood pressure, and it is not advisable to ingest cannabis directly. The oil can also have a bad taste that lingers in the mouth (Ruixing et al. 2008).

16.4.4.2 Saw Palmetto (*Serenoa repens*)

This plant's ripe fruit is used to make medicine. This plant is rich in fatty acids and phytosterols (Lust 2014). It has been used in traditional medicine to treat benign prostatic hyperplasia and to decrease the symptoms of an enlarged prostate (Tacklind et al. 2012). This herb has repeatedly been shown, in multiple studies, to reduce prostate cancer inflammation and enlargement. It appears to be completely safe to use, with no side effects. It also works for over 90% patients after 4–6 weeks (Champault et al. 1984). Traditional medicine suggests a dose of 320 mg of saw palmetto, daily for 2 months before prostate surgery to minimise the risk of surgery and blood loss (Lust 2014).

16.4.4.3 Cayenne Pepper (*Capsicum annuum*)

It is also known as the cow-horn pepper, guinea spice, red hot chili pepper. Cayenne is used in cooking, as a powder or in its whole form. Cayenne consumption dilates blood vessels and speeds the metabolism due to high levels of capsaicin (Lust 2014). Capsaicin has a profound anti-proliferative effect on human prostate cancer, as well as inhibiting tumour necrosis factor and inducing apoptosis through regulation of many gene expressions (Mori et al. 2006). Capsaicin was found to increase the levels of certain proteins involved in apoptosis and also reduced the number of prostate-specific antigens (Scher et al. 1999). Other benefits include helping to prevent ulcers, opening and draining congested nasal passages, and reducing cell damage that can lead to diabetic complications (Sánchez et al. 2007; Ramos-Torres et al. 2015). Herbalists suggest 400 mg/day, three times/week of capsaicin to treat prostate cancer (Kapoor 2000).

16.4.4.4 Stinging Nettle (*Urtica dioica*)

This is a plant grows in North America, Europe, and Africa that has been used as an herbal remedy for thousands of years. The name comes from the stinging sensation that arises when parts of the body brush against the plant's hairy stems and leaves (Lust 2014). Its leaves have been used successfully to reduce symptoms associated with prostatitis in Europe for over a decade. Prostatitis is a noncancerous condition that causes the prostate gland to enlarge, making urination difficult (Shoskes 2002). Nettles can be eaten on their own or as an ingredient in foods; the leaves must be cooked or steamed to destroy the hairs, which contain a number of irritating chemicals (Lust 2014).

16.4.4.5 Black Seed (*Nigella sativa*)

This plant's seeds have often been used to make medicines to treat headache and toothache (Lust 2014). It also manifests some potent antitumour and anticancer properties (Khan et al. 2011; Randhawa and Alghamdi 2011). This plant has been studied extensively in terms of treating cancer, as many herbalists adopt this natural treatment for patients with prostate problems (Gilani et al. 2004).

16.4.4.6 Lycopene

This is a naturally occurring chemical that manifests as a red pigment contained in common foods such as tomatoes, pink grapefruits, guava, and watermelon (Giovannucci 1999). This is a very strong antioxidant that has been found to prevent and even reverse the progression of prostate cancer, as well as treating benign prostatic hyperplasia. In a recent study, 30 mg a day of lycopene showed curative results in prostate cancer. For best results, supplements are recommended alongside eating and drinking plenty of lycopene-containing food and juices (Jatoi et al. 2007). Earlier research showed that taking a specific combination of lycopene, selenium, and saw palmetto by mouth for 8 weeks reduced pain in men with prostate swelling and pelvic pain more significantly than saw palmetto alone (Feifer et al. 2002).

16.5 Medicinal Plants: Safety, Toxicity, and Adulteration Issues

Herbal products have been used as medicines for centuries, and their use has continued into the current age. In recent years, herbal medicine has once more become popular, and it is widely adopted in Western culture; this has drawn the attention of the research community to the potential of the herbs used in Asian and African traditional medicines also. Using herbal medicines as a primary treatment or as an adjunct treatment to pharmaceutical remedies is a feasible approach, but the latter combination may be the preferred choice to benefit from the synergistic effects of both treatments, which may yield an improved curative effect and minimise the side effects of conventional treatment (Girard and Vohra 2011).

Although many herb users reported the benevolence of traditional treatments in terms of preserving good health, treating sickness, and mitigating the side effects of conventional medication, most herbal remedies have not been extensively investigated in clinical settings (Bateman et al. 1998). Those, caution should be taken when using herbs for fear of aggravating health conditions; the safety of patients must be the first priority. Clinical effort should be expended to consider all the advantages and hazards to a patient in order to achieve best recuperative results. Herbal medicines may pose harm to patients for several reasons, including allergic reactions, drug-herb interactions, adulteration of products, and contamination of substances (Girard and Vohra 2011).

16.5.1 Allergic Reactions

Some patients may suffer an adverse effect to any medication. This is more commonly found in in asthma sufferers, pregnant woman, and children. Allergic reactions to herbal remedies may be due to allergens present in some pollen or other plant parts. Plants belonging to the genus, *Echinacea*, can cause stinging of the tongue or transient burning sensations if eaten uncooked or semi-cooked, and some patients suffer from pollen-induced asthma on use. Although the benefits of *Echinacea* species are well documented in traditional practice, the most common side effect is an upset stomach (Damato et al. 2007). Other people may be truly allergic to this herb, developing symptoms such as rashes, worsening of asthma symptoms, and even anaphylaxis (trouble breathing). Patients are at higher risk of having a reaction to *Echinacea* if they are allergic to Asteraceae family plants such as ragweed, marigolds, and chrysanthemums (Bauer 1998). *Aloe vera* was reported to cause abdominal pains and diarrhoea and to be potentially carcinogenic when taken with other medication such as cardiac glycosides and antiarrhythmic agents (Blumenthal 2000). Liquorice root (*Glycyrrhiza glabra*) may cause hypokalaemia, hypertension and arrhythmias, and oedema in some patients (Mumoli and Cei 2008). Saw palmetto can cause gastrointestinal upsets, diarrhoea, gynecomastia, and paroxysmal atrial fibrillation (Ernst 2002). Burdock may cause allergic reactions in people sensitive to certain flowers and herbs, again including chrysanthemums, marigolds, and daisies, causing rashes on the skin. It can slow down blood clotting and may increase the risk of bleeding in people with bleeding disorders, as well as increasing the risk of bleeding during and after surgery. Taking burdock might lower sugar levels, which is potentially dangerous in diabetes patients who are already under medication to lower blood sugar levels (Chan et al. 2011).

Large doses of ashwagandha can upset the stomach, causing diarrhoea and vomiting. It can also cause more serious side effects in some people, such as abnormal heart rhythms, breathing problems, and sedation. Unprocessed celandine can cause mucous membrane and skin irritation. Direct consumption may cause severe irritation of the stomach and intestines, and liver damage and acute hepatitis have been reported (Benninger et al. 1999; Gilca et al. 2010). Side effects of taking cannabis oil include memory loss and random thoughts. It causes an increased heart rate and imbalances in the body (Hall and Degenhardt 2009; Volkow et al. 2014). Stinging nettle (*Urtica dioica*) leaf may cause burning and itching or even a rash on sensitive skin. It may also cause low blood pressure, fluctuation of blood sugar levels, and digestive discomfort (Setty and Sigal 2005). Some patients reported that it also encourages bleeding and can cause uterine contractions. It is thus risky to take stinging nettle if pregnant or breast feeding (Westfall 2001). It may also interact with some other medications and is not recommended for patients taking blood thinning diuretics, blood pressure control medication, and anti-inflammatory drugs. It also interacts with alpha-blockers and finasteride (Calahan et al. 2016).

16.5.2 Drug-Herb Interaction

From the perspective of drug-herb interactions, herbal products can frequently have drug interactions with prescription medications. Some herbal medication is privately processed and not verified or licenced by authorities; such products are not labelled with safety warnings. Herbs with potent chemicals may breakdown drugs' components in a patient's body, causing side effects from prescription medication, and blocking the intended therapeutic effects of drugs. Echinacea is commonly known for its interactions with drugs, slowing down the breakdown of caffeine and causing side effects including nervousness, headaches, and insomnia (Bauer 1998). Saw palmetto, which is popular in treating prostate cancer, is not complimentary with finasteride. Saw palmetto can also interact with warfarin to cause bleeding and slow blood clotting. If saw palmetto is taken with oestrogen or oral contraceptives, the effectiveness of these hormones could be reduced (Rowland and Tai 2003). Ginseng is used for improving vitality but was reported to have many drug interactions; it should not be used with anticoagulants, insulin, or oral hypoglycaemics (Luo and Luo 2009). Garlic is a culinary flavouring agent, but it has an additive effect with warfarin that affects blood sugar level and blood clotting in patients; garlic may also react with clopidogrel (Vaes and Chyka 2000). Green tea, a popular drink in China and Japan to prevent stomach disorders, interferes with the activity of some blood thinners such as warfarin. Ginger is also another example of culinary herb that prolongs bleeding and may have interactions with warfarin and aspirin that cause iris bleeding (Vaes and Chyka 2000).

16.5.3 Adulterants in Herbs

Adulteration usually refers to non-compliance with health and safety standards, making the herbs directly harmful or reducing their potency so that they are harmless but ineffective. The most commonly used form of adulteration by manufacturers is the addition of undeclared materials that are cheaper than the declared substances (Ko 1998; Swamy and Sinniah 2016; Mohanty et al. 2017). The chemical and biomedical analysis methods used by authorities to detect chemical adulterants in herbal medication are liquid chromatography, gas chromatography, flow injection, and capillary electrophoresis. Several review papers are discussed on herbal screening to identify such additives (But 1994). Ginseng is now banned by the Food and Drug Administration, USA, as it frequently contains dexamethasone (a corticosteroid) and chlorpheniramine. Dexamethasone can cause immunity impairment, increase blood sugar levels, and cause psychiatric complications (Calahan et al. 2016). Corticosteroids are the most common adulterant reported in many Chinese herbal medicines (Ernst 2002). A report from Taiwan showed that 1/5 of samples investigated were contaminated with at least one conventional pharmacological adulterant. This reveals that adulterants are potentially a large problem for traditional medicine (Ernst 2002).

16.5.4 Contaminated Herbal Medication

There has been an increasing concern over food safety and traceability, and in terms of herbal medication, while herbs are used for the prevention of ailments and treating sickness, the lack of safety and potential toxicity of several herbs available on the market have shaken some people's confidence in the field. Many research projects screening for heavy metals found lead and arsenic to be major problems in herbal preparations (Mitchell-Heggs et al. 1990; Swamy and Sinniah 2016). Heavy metals such as zinc, copper, iron, and manganese are essential nutrient in micro quantities; however, above certain permissible limits, the presence of these heavy metals in herbal medication can become toxic and potentially lethal to sensitive patients (Byard 2010; Dghaim et al. 2015). Some Chinese herbal medicine is reported to cause heavy metal poisoning, where metals exceed acceptable standard consumption for daily intake (Ernst 2002). In Ayurvedic medicinal herbs, lead, mercury, and arsenic contamination have been reported (Saper et al. 2004). Herbal remedies are rapidly gaining popularity throughout the world, but there is dissatisfaction with the production standards currently used. Most people have the conceptual idea that herbal preparations are natural and therefore intrinsically harmless; in fact, improper herbal prescriptions, unintended drug interactions, adulterants, and unregulated heavy metal content in herbs can be very powerful and potentially lethal issues that make them less safe than conventional medicines (Ahmad et al. 2006).

16.6 Herbal Medicine: A Brief Insight into Economic Value

The prevalence of ethnomedicine in developing countries is greater than in developed countries, thanks to local belief and a general acceptance of the ideology that herbs are natural medicines; however, ethnomedicine is often perceived as unreliable, and less clinical evidence is available for it in developed countries. The explanation of why ethnomedicine is still widely practised in many places is most people cannot afford modern medicine and have no access to pharmaceutical health care (Yager et al. 2008). Over 80% of the African population rely on traditional African medicine even though this is not developed to a comparable standard to modern pharmaceutical products, and many Africans suffer from shortage of critical drugs and die from curable diseases (Elujoba et al. 2005; WHO 2014). For developing or ethnomedicine rich countries, development of native medicinal plants could be an important step towards improving accessibility of effective pharmaceuticals, as well as boosting the economic status of those countries (Ahmad et al. 2006).

Based on the findings of Global Industry Analysis on the global herbal product industry, Singapore's herbal products sales reached SGD 299 million and grew by 3% in 2016. This could be due to the good reputation and quality of the products available there, which are less processed and have fewer side effects. An example of a successful traditional medicine entrepreneur is Cerebos Pacific, Singapore, the leading player, whose signature product is Brand's Essence of Chicken. The World Health Organization (WHO) notes that herbal medicine can be turned into wealth.

In Saudi Arabia, herbal products are experiencing stronger demand, and this industry has an estimated annual growth of 9%. Other examples of successful traditional medicine companies are Mondelez Eastern Europe and Middle East & Africa FZE. In the United Arab Emirates (UAE), they are keen on herbal alternatives for daily household and herbal remedies, boosting sales of natural health products. The leading player in UAE is Ricola. For Japan, herbal products experienced 1% growth in 2016, with a sales value of JPY382 billion. Miki Corp is the Japanese leading player in terms of herbal products, and it has forecast sales in 2021 of JPY392 billion. For New Zealand, natural health and supplementary products based on herbs are currently being debated in parliament. This is likely to invite more herbal manufacturers to invest there in the future to produce licenced products. In Sweden, herbal products experienced 3% growth in 2016, Cloetta Sverige remains the sales leader in this herbal industry, but it is potentially prone to slightly weaker growth due to consumer scepticism surrounding the efficacy of herbal products. In many Asian countries, such as Thailand, Vietnam, Hong Kong, and the Philippines, there is a general strong acceptance of herbal products. Most of the herbal products in these countries are expected to increase sales over time due to stable demand and product acceptance.

In general, the herbal medicine market is estimated to reach USD107 billion in 2017 in the global market (Montes and Zapata Jr. 2012). China and India monopolise the herbal product industry, with their shares in the global market reaching a value of USD 60 billion. Chinese medicines are standardised and have authenticity in the global market. China has also created a database of its ancient knowledge of herbs, adding a modern flavour. Its budget recently included USD 3.6 million for a project to screen both conventional chemical compounds and medicinal herbs to boost drug invention. Hong Kong invested USD 64 million to construct Institute of Chinese Medicine, and Taiwan proposes USD 1.5 million to develop the Taiwan Chinese Medicinal Herb Industry (Mukherjee 2015).

16.7 Conclusions and Future Prospects

Although substantial progress has been made in the fields of cancer research towards fast track diagnosis and chemotherapy, it still remains as one of the menace causing the highest death across the globe. Hence, there is an urgent need to take measures to curb and prevent cancer. Treatments using chemically derived drugs have limitations as they cause toxicity effects on normal tissues and extend many health problems. In this regard, alternative therapies using natural anticancer agents obtained from plants are more attractive and desired. Plant-based compounds are effective against different cancer types with lesser side effects and induce multiple mechanisms of action against the target cells. Plant metabolites such as phenolic compounds, flavonoids, alkaloids, and brassinosteroids are reported to possess superior anticancer properties. These compounds are known to destroy tumour cells by various ways, for example, inducing antioxidant activities, inhibiting cancer cell growth, and inducing apoptosis process. Various plant-derived compounds such as

paclitaxel, podophyllotoxin, camptothecin, etc. are already in the market for the treatment of various cancer types, and few more novel drug molecules are in the discovery phases. A recent progress in the fields of nanobiotechnology has shown some hope to cure cancer effectively by conjugating various nanoparticles with plant anticancer compounds. Nanoparticles are very useful in controlling the sustained release of anticancer drugs and thus help to develop novel drugs targeting specific tissues with negligible side effects of treatments.

In the face of increasing use and a fast-growing market for herbal medicine and other herbal health-care products, some core issues or weaknesses of herbal medicine are still to be faced; these are generally related to the safety, efficacy, and quality of herbal products. To be more specific, the correct identification of herbal materials and pharmacologically active constituents, along with standardization in production, is the key to gaining trust from the modern medical community, which is required to improve the prevalence of herbal medicine aside from public demand for herbs as supplements. In the present situation, for herbal medicine to be legalised and synchronised with modern medicine, policymakers and health professionals must be presented with additional scientific evidence on the quality, efficacy, and safety of such remedies by researchers. Taking this into consideration, it may be concluded that herbal medicine offers good future prospects and may emerge as good option for the treatment of cancers, subject to further research. However, utilisation of plant-derived anticancer agents needs better management to meet the global demands.

References

Abdullah S, Abidin SAZ, Murad NA, Makpol S, Ngah WZW, Yusof YAM (2010) Ginger extract (*Zingiber officinale*) triggers apoptosis and G0/G1 cells arrest in HCT 116 and HT 29 colon cancer cell lines. Afr J Biochem Res 4:134–142

Aggarwal BB, Kumar A, Bharti AC (2003) Anticancer potential of curcumin: preclinical and clinical studies. Anticancer Res 23:363–398

Agrawal DK, Mishra PK (2010) Curcumin and its analogues: potential anticancer agents. Med Res Rev 30:818–860

Ahmad I, Aqil F, Owais M (2006) Modern phytomedicine: turning medicinal plants into drugs. Wiley, Hoboken

Akhtar MS, Birhanu G, Demisse S (2014a) Antimicrobial activity of *Piper nigrum* L. and *Cassia didymobotyra* L. leaf extract on selected food borne pathogens. Asian Pac J Trop Dis 4:S911–S919

Akhtar MS, Degaga B, Azam T (2014b) Antimicrobial activity of essential oils extracted from medicinal plants against the pathogenic microorganisms: a review. Biol Sci Pharm Res 2:1–7

Akram M, Shahab-Uddin AA, Usmanghani K, Hannan A, Mohiuddin E, Asif M (2010) *Curcuma longa* and curcumin: a review article. Rom J Biol Plant Biol 55:65–70

Al-Snafi AE (2016) The pharmacological activities of *Cuminum cyminum*-a review. IOSR J Pharm 6:46–65

Aly AM, Al-Alousi L, Salem HA (2005) Licorice: a possible anti-inflammatory and anti-ulcer drug. AAPS Pharm Sci Tech 6:E74–E82

Arumugam G, Swamy MK, Sinniah UR (2016) *Plectranthus amboinicus* (Lour.) Spreng: botanical, phytochemical, pharmacological and nutritional significance. Molecules 21:369

Asl MN, Hosseinzadeh H (2008) Review of pharmacological effects of *Glycyrrhiza* sp. and its bioactive compounds. Phytother Res 22:709–724

Aung TN, Qu Z, Kortschak RD, Adelson DL (2017) Understanding the effectiveness of natural compound mixtures in cancer through their molecular mode of action. Int J Mol Sci 18:656. https://doi.org/10.3390/ijms18030656

Bajguz A, Tretyn A (2003) The chemical characteristic and distribution of brassinosteroids in plants. Phytochemistry 62:1027–1046

Balentine DA, Wiseman SA, Bouwens LC (1997) The chemistry of tea flavonoids. Crit Rev Food Sci Nutr 37:693–704

Banerjee S, Panda CK, Das S (2006) Clove (*Syzygium aromaticum* L.), a potential chemopreventive agent for lung cancer. Carcinogenesis 27:1645–1654

Bardaweel S, Hudaib M, Tawaha K (2014) Evaluation of antibacterial, antifungal, and anticancer activities of essential oils from six species of *Eucalyptus*. J Essent Oil Bear Plant 17:1165–1174

Barnes J, Anderson LA, Gibbons S, Phillipson JD (2005) Echinacea species (*Echinacea angustifolia* (DC.) Hell., *Echinacea pallida* (Nutt.) Nutt., *Echinacea purpurea* (L.) Moench): a review of their chemistry, pharmacology and clinical properties. J Pharm Pharmacol 57:929–954

Bateman J, Chapman R, Simpson D (1998) Possible toxicity of herbal remedies. Scott Med J 43:7–15

Bauer R (1998) Echinacea: biological effects and active principles. ACS Symp Ser 691:140–157. https://doi.org/10.1021/bk-1998-0691.ch012

Benninger J, Schneider HT, Schuppan D, Kirchner T, Hahn EG (1999) Acute hepatitis induced by greater celandine (*Chelidonium majus*). Gastroenterol 117:1234–1237

Bhujade A, Gupta G, Talmale S, Das S, Patil M (2013) Induction of apoptosis in A431 skin cancer cells by *Cissus quadrangularis* Linn stem extract by altering Bax-Bcl-2 ratio, release of cytochrome c from mitochondria and PARP cleavage. Food Funct 4:338–346

Blumenthal M (2000) Interaction between herbs and conventional drugs: introductory considerations. HerbalGram 49:52–63

Boivin D, Blanchette M, Barrette S, Moghrabi A, Beliveau R (2007) Inhibition of cancer cell proliferation and suppression of TNF-induced activation of NFκB by edible berry juice. Anticancer Res 27:937–948

Burns J, Yokota T, Ashihara H, Lean ME, Crozier A (2002) Plant foods and herbal sources of resveratrol. J Agric Food Chem 50:3337–3340

But P (1994) Herbal poisoning caused by adulterants or erroneous substitutes. Am J Trop Med Hyg 97:371–374

Byard RW (2010) A review of the potential forensic significance of traditional herbal medicines. J Forensic Sci 55:89–92

Calahan J, Howard D, Almalki AJ, Gupta MP, Calderón AI (2016) Chemical adulterants in herbal medicinal products: a review. Planta Med 82:505–515

Carte BK, DeBrosse C, Eggleston D, Hemling M, Mentzer M, Poehland B, Troupe N, Westley JW, Hecht SM (1990) Isolation and characterization of a presumed biosynthetic precursor of camptothecin from extracts of *Camptotheca acuminata*. Tetrahedron 46:2747–2760

Champault G, Patel J, Bonnard A (1984) A double-blind trial of an extract of the plant *Serenoa repens* in benign prostatic hyperplasia. Br J Clin Pharmacol 18:461–462

Chan YS, Cheng LN, Wu JH, Chan E, Kwan YW, Lee SM, Leung GP, Yu PH, Chan SW (2011) A review of the pharmacological effects of *Arctium lappa* (burdock). Inflammopharmacology 19:245–254

Cragg GM, Newman DJ (2005) Plants as a source of anti-cancer agents. J Ethnopharmacol 100:72–79

Creţu E, Trifan A, Vasincu A, Miron A (2012) Plant-derived anticancer agents-curcumin in cancer prevention and treatment. Rev Med Chir Soc Med Natlasi 116:1223–1229

Cui Y, Shu XO, Gao YT, Cai H, Tao MH, Zheng W (2006) Association of ginseng use with survival and quality of life among breast cancer patients. Am J Epidemiol 163:645–653

Damato G, Cecchi L, Bonini S, Nunes C, Annesi-Maesano I, Behrendt H, Liccardi G, Popov T, van Cauwenberge P (2007) Allergenic pollen and pollen allergy in Europe. Allergy 62:976–990

Danciu C, Vlaia L, Fetea F, Hancianu M, Coricovac DE, Ciurlea SA, Şoica CM, Marincu I, Vlaia V, Dehelean CA, Trandafirescu C (2015) Evaluation of phenolic profile, antioxidant and anticancer potential of two main representants of *Zingiberaceae* family against B164A5 murine melanoma cells. Biol Res 48:1. https://doi.org/10.1186/0717-6287-48-1

De Silva DD, Rapior S, Fons F, Bahkali AH, Hyde KD (2012) Medicinal mushrooms in supportive cancer therapies: an approach to anti-cancer effects and putative mechanisms of action. Fungal Divers 55:1–35

Del Follo-Martinez A, Banerjee N, Li X, Safe S, Mertens-Talcott S (2013) Resveratrol and quercetin in combination have anticancer activity in colon cancer cells and repress oncogenic microRNA-27a. Nutri Cancer 65:494–504

Dghaim R, Al Khatib S, Rasool H, Ali Khan M (2015) Determination of heavy metals concentration in traditional herbs commonly consumed in the United Arab Emirates. J Environ Public Health 2015:6. https://doi.org/10.1155/2015/973878

Dumbravă DG, Hădărugă NG, Hădărugă DI, Gruia A, Tatu C, Păunescu V, Lupea AX (2008) Antioxidant activity of some celandine (*Chelidonium majus* L.) carotenoidic extract. J Agroaliment Process Technol 14:433–441

Dwivedi V, Shrivastava R, Hussain S, Ganguly C, Bharadwaj M (2011) Comparative anticancer potential of clove (*Syzygium aromaticum*)-an Indian spice against cancer cell lines of various anatomical origin. Asian Pac J Cancer Prev 12:1989–1993

Elujoba AA, Odeleye O, Ogunyemi C (2005) Traditional medicine development for medical and dental primary health care delivery system in Africa. Afr J Tradit Complement Altern Med 2:46–61

Ernst E (2002) Adulteration of Chinese herbal medicines with synthetic drugs: a systematic review. J Intern Med 252:107–113

Fabricant DS, Farnsworth NR (2001) The value of plants used in traditional medicine for drug discovery. Environ Health Perspect 109:69–75

Farshori NN, Al-Sheddi ES, Al-Oqail MM, Musarrat J, Al-Khedhairy AA, Siddiqui MA (2013) Anticancer activity of *Petroselinum sativum* seed extracts on MCF-7 human breast cancer cells. Asian Pac J Cancer Prev 14:5719–5723

Feifer AH, Fleshner NE, Klotz L (2002) Analytical accuracy and reliability of commonly used nutritional supplements in prostate disease. J Urol 168:150–154

Ferlay J, Soerjomataram I, Ervik M, Dikshit R, Eser S, Mathers C, Rebelo M, Parkin DM, Forman D, Bray F (2014) Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. Int J Cancer 136:E359–E386

Fiore C, Eisenhut M, Ragazzi E, Zanchin G, Armanini D (2005) A history of the therapeutic use of liquorice in Europe. J Ethnopharmacol 99:317–324

Fischer J, Ganellin CR (2010) Analogue-based drug discovery II. Wiley, Hoboken

Gali-Muhtasib H, Hmadi R, Kareh M, Tohme R, Darwiche N (2015) Cell death mechanisms of plant-derived anticancer drugs: beyond apoptosis. Apoptosis 20:1531–1562

Gardner Z, McGuffin M (2013) American Herbal Products Association's botanical safety handbook. CRC Press, Boca Raton

Gezahegn Z, Akhtar MS, Woyessa D, Tariku Y (2015) Antibacterial potential of *Thevetia peruviana* leaf extracts against food associated pathogens. J Coast Life Med 3:150–157

Giddings LA, Newman DJ (2013) Microbial natural products: molecular blueprints for antitumor drugs. J Indian Microbiol Biotechnol 40:1181–1210

Gilani A-uH, Jabeen Q, Khan MAU (2004) A review of medicinal uses and pharmacological activities of *Nigella sativa*. Pak J Biol Sci 7:441–445

Gilca M, Gaman L, Panait E, Stoian I, Atanasiu V (2010) *Chelidonium majus*–an integrative review: traditional knowledge versus modern findings. Forsch Komplementmed 17:241–248

Giovannucci E (1999) Tomatoes, tomato-based products, lycopene, and cancer: review of the epidemiologic literature. J Natl Cancer Inst 91:317–331

Girard L, Vohra S (2011) 21 ethics of using herbal medicine as primary or adjunct treatment and issues of drug-herb interaction. In: Benzie IFF, Wachtel-Galor S (eds) Herbal medicine: biomolecular and clinical aspects, 2nd edn. CRC Press/Taylor & Francis, Boca Raton

Greenwell M, Rahman P (2015) Medicinal plants: their use in anticancer treatment. Int J Pharm Sci Res 6:4103–4112

Guo L, Bai SP, Zhao L, Wang XH (2012) *Astragalus* polysaccharide injection integrated with vinorelbine and cisplatin for patients with advanced non-small cell lung cancer: effects on quality of life and survival. Med Oncol 29:1656–1662

Gupta PC (2012) Biological and pharmacological properties of *Terminalia chebula* retz.(haritaki)-an overview. Int J Pharm Pharm Sci 4:62–68

Gupta S, Zhang D, Yi J, Shao J (2004) Anticancer activities of *Oldenlandia diffusa*. J Herb Pharmacother 4:21–33

Hall W, Degenhardt L (2009) Adverse health effects of non-medical cannabis use. Lancet 374:1383–1391

Hermanson DJ, Marnett LJ (2011) Cannabinoids, endocannabinoids, and cancer. Cancer Metastasis Rev 30:599–612

Hong L, Ying SH (2015) Ethanol extract and isolated constituents from *Artemisia dracunculus* inhibit esophageal squamous cell carcinoma and induce apoptotic cell death. Drug Res 65:101–106

Hu S, Huang L, Meng L, Sun H, Zhang W, Xu Y (2015) Isorhamnetin inhibits cell proliferation and induces apoptosis in breast cancer via Akt and mitogen-activated protein kinase kinase signaling pathways. Mol Med Rep 12:6745–6751

Huang KC (1998) The pharmacology of Chinese herbs. CRC Press, Bocca Raton

Huang XF, Lin YY, Kong LY (2008) Steroids from the roots of *Asparagus officinalis* and their cytotoxic activity. J Integr Plant Biol 50:717–722

Jain SK, Meena S, Gupta AP, Kushwaha M, Uma Shaanker R, Jaglan S, Bharate SB, Vishwakarma RA (2014) *Dysoxylum binectariferum* bark as a new source of anticancer drug camptothecin: bioactivity-guided isolation and LCMS-based quantification. Bioorg Med Chem Lett 24:3146–3149

Jankun J, Selman SH, Swiercz R, Skrzypczak-Jankun E (1997) Why drinking green tea could prevent cancer. Nature 387:561. https://doi.org/10.1038/42381

Jatoi A, Burch P, Hillman D et al (2007) A tomato-based, lycopene-containing intervention for androgen-independent prostate cancer: results of a Phase II study from the North Central Cancer Treatment Group. Urology 69:289–294

Jiang WG, Ye L, Ji K, Frewer N, Ji J, Mason MD (2012) Inhibitory effects of Yangzheng Xiaoji on angiogenesis and the role of the focal adhesion kinase pathway. Int J Oncol 41:1635–1642

Jiang WG, Ye L, Ruge F, Owen S, Martin T, Sun PH, Sanders AJ, Lane J, Satherley L, Weeks HP, Gao Y, Wei C, Wu Y, Mason MD (2015) Yang Zheng Xiao Ji exerts anti-tumour growth effects by antagonising the effects of HGF and its receptor, cMET, in human lung cancer cells. J Transl Med 13:280. https://doi.org/10.1186/s12967-015-0639-1

Kapoor L (2000) Handbook of Ayurvedic medicinal plants: herbal reference library, vol 2. CRC Press, Bocca Raton

Khan MA, Chen HC, Tania M, Zhang DZ (2011) Anticancer activities of *Nigella sativa* (black cumin). Afr J Tradit Complement Altern Med 8:226–232

Kim SA, Sung YK, Kwon BM, Yoon JH, Lee H, Ahn SG, Hong SH (2010) 2′-Hydroxycinnamaldehyde shows antitumor activity against oral cancer *in vitro* and *in vivo* in a rat tumor model. Anticancer Res 30:489–494

Kirana C, Jones GP, Record IR, McIntosh GH (2007) Anticancer properties of panduratin A isolated from *Boesenbergia pandurata* (Zingiberaceae). J Nat Med 61:131–137

Ko RJ (1998) Adulterants in Asian patent medicines. N Engl J Med 339:847–847

Kumara PM, Zuehlke S, Priti V, Ramesha BT, Shweta S, Ravikanth G, Vasudeva R, Santhoshkumar TR, Spiteller M, Uma Shaanker R (2012) *Fusarium proliferatum*, an endophytic fungus from *Dysoxylum binectariferum* Hook. F., produces rohitukine, a chromane alkaloid possessing anticancer activity. Antonie Van Leeuwenhoek 101:323–329

Lee JH, Lee SJ, Park S, Jeong SW, Kim CY, Jin JS, Jeong ED, Kwak YS, Kim ST, Bae DW, Kim GS, Shin SC (2012) Determination of flavonoid level variation in onion (*Allium cepa*

L.) infected by *Fusarium oxysporum* using liquid chromatography–tandem mass spectrometry. Food Chem 133:1653–1657
Leem J (2015) Is traditional Chinese herbal medicine effective in prolonging survival times in extensive-stage small-cell lung cancer patients. Integr Med Res 4:256–259
Li D, Xu X, Bao D, Xue F, Dai D (2009) Effects of kanglaite capsules combined with transcatheter arterial chemoembolization (TACE) on patients with mid or late-stage primary hepatocellular carcinoma (HCC). Chin Ger J Clin Oncol 8:65–68
Lim TK (2012) Ribes rubrum. In: Lim TK (ed) Edible medicinal and non-medicinal plants. Springer, Dordrecht, pp 43–50
Liu Z (2009) Infantile cough. Essentials of Chinese medicine. In: Liu Z (ed) Essentials of Chinese medicine. Springer, London, pp 333–338
Liu S, Sun J (2007) Effect of 'Jinfukang oral solution' on expression of apoptosis related genes of human lung adenocarcinoma cells transplanted in nude mice. Shang J Tradit Chin Med 10:69–71
Liu J, Shi Z, Xu Z, Zhu Y, Zhao L, Li H, Gao H, Chen S (2000) Clinical observation on treatment of non-parvicellular carcinoma of the lung with jin fu kang oral liquid. J Tradit Chin Med 20:96–100
London C (2010) Functional foods that boost the immune system. In: Smith J, Charter E (eds), Functional food product development, Wiley-Blackwell, Oxford
Lu Y, Li CS, Dong Q (2008) Chinese herb related molecules of cancer-cell-apoptosis: a minireview of progress between Kanglaite injection and related genes. J Exp Clin Cancer Res 27:31. https://doi.org/10.1186/1756-9966-27-31
Łuczaj W, Skrzydlewska E (2005) Antioxidative properties of black tea. Prev Med 40:910–918
Luo JZ, Luo L (2009) Ginseng on hyperglycemia: effects and mechanisms. Evid Based Complement Alternat Med 6:423–427
Lust J (2014) The herb book: the most complete catalog of herbs ever published. Courier Corporation, New York
Malíková J, Swaczynová J, Kolář Z, Strnad M (2008) Anticancer and antiproliferative activity of natural brassinosteroids. Phytochemistry 69:418–426
McCulloch M, See C, Shu XJ, Broffman M, Kramer A, Fan WY, Gao J, Lieb W, Shieh K, McCulloch M, See C, Shu XJ, Broffman M, Kramer A, Fan WY, Gao J, Lieb W, Shieh K, Colford JJM (2006) *Astragalus* based Chinese herbs and platinum-based chemotherapy for advanced non–small-cell lung cancer: meta-analysis of randomized trials. J Clin Oncol 24:419–430
McGuire WP, Hoskins WJ, Brady MF, Kucera PR, Partridge EE, Look KY, Clarke-Pearson DL, Davidson M (1996) Cyclophosphamide and cisplatin compared with paclitaxel and cisplatin in patients with stage III and stage IV ovarian cancer. N Engl J Med 334:1–6
McNamara S, Song XK (1995) Traditional Chinese medicine. Hamish Hamilton, London
Miller K, Wang M, Gralow J, Dickler M, Cobleigh M, Perez EA, Shenkier T, Cella D, Davidson NE (2007) Paclitaxel plus bevacizumab versus paclitaxel alone for metastatic breast cancer. N Engl J Med 357:2666–2676
Mishra BB, Tiwari VK (2011) Natural products: an evolving role in future drug discovery. Eur J Med Chem 46:4769–4807
Mishra LC, Singh BB, Dagenais S (2000) Scientific basis for the therapeutic use of *Withania somnifera* (ashwagandha): a review. Altern Med Rev 5:334–346
Mishra A, Sharma AK, Kumar S, Saxena AK, Pandey AK (2013) *Bauhinia variegata* leaf extracts exhibit considerable antibacterial, antioxidant, and anticancer activities. Bio Med Res Int 2013:915436. https://doi.org/10.1155/2013/915436
Mitchell-Heggs C, Conway M, Cassar J (1990) Herbal medicine as a cause of combined lead and arsenic poisoning. Hum Exp Toxicol 9:195–196
Mohandas K, Desai D (1998) Epidemiology of digestive tract cancers in India. V. Large and small bowel. Indian J Gastroenterol 18:118–121
Mohanty SK, Swamy MK, Sinniah UR, Anuradha M (2017) *Leptadenia reticulata* (Retz.) Wight & Arn. (Jivanti): botanical, agronomical, phytochemical, pharmacological, and biotechnological aspects. Molecules 22:1019. https://doi.org/10.3390/molecules22061019

Montes ND, Zapata NR Jr (2012) Opportunities and challenges in the emerging global herbal medicine industry. J Glob Bus Trade 8:67–78
Mori A, Lehmann S, O'Kelly J, Kumagai T, Desmond JC, Pervan M, McBride WH, Kizaki M, Koeffler HP (2006) Capsaicin, a component of red peppers, inhibits the growth of androgen-independent, p53 mutant prostate cancer cells. Cancer Res 66:3222–3229
Mukherjee PK (2015) Evidence-based validation of herbal medicine. Elsevier, Boston
Mumoli N, Cei M (2008) Licorice-induced hypokalemia. Int J Cardiol 124:e42–e44
Naik G, Priyadarsini K, Mohan H (2006) Free radical scavenging reactions and phytochemical analysis of triphala, an ayurvedic formulation. Curr Sci 90:1100–1105
Normile D (2003) The new face of traditional Chinese medicine. Science 299:188–190
Obolskiy D, Pischel I, Feistel B, Glotov N, Heinrich M (2011) *Artemisia dracunculus* l. (tarragon): a critical review of its traditional use, chemical composition, pharmacology, and safety. J Agric Food Chem 59:11367–11384
Ouyang X, Wang X, Lee D, Tsao S, Wong Y (2002) Over expression of ID-1 in prostate cancer. J Urol 167:2598–2602
Potmesil M, Pinedo HM (1994) Camptothecins new anticancer agents. CRC Press, Bocca Raton
Potter JD, Slattery ML, Bostick RM, Gapstur SM (1993) Colon cancer: a review of the epidemiology. Epidemiol Rev 15:499–545
Poucheret P, Fons F, Rapior S (2006) Biological and pharmacological activity of higher fungi: 20-year retrospective analysis. Cryptogamie Mycol 27:311–333
Prakash E, Gupta DK (2014) Cytotoxic activity of ethanolic extract of *Cuminum cyminum* Linn against seven human cancer cell line. Univers J Agric Res 2:27–30
Ramos-Torres A, Morell C, Bort A, Rodriguez-Henche N, Diaz-Laviada I (2015) Capsaicin induces autophagy in prostate cancer cells through reactive oxygen species generation. FEBS J 282:361
Randhawa MA, Alghamdi MS (2011) Anticancer activity of Nigella sativa (black seed)-a review. Am J Chin Med 39:1075–1091
Rárová L, Zahler S, Liebl J, Kryštof V, Sedlák D, Bartůněk P, Kohout L, Strnad M (2012) Brassinosteroids inhibit *in vitro* angiogenesis in human endothelial cells. Steroids 77:1502–1509
Rowland DL, Tai W (2003) A review of plant-derived and herbal approaches to the treatment of sexual dysfunctions. J Sex Marital Ther 29:185–205
Ruixing Y, Weixiong L, Hanjun Y, Dezhai Y, Shuquan L, Shangling P, Qiming F, Jinzhen W, Jianting G, Yaju D (2008) Diet, lifestyle, and blood pressure of the middle-aged and elderly in the Guangxi Bai Ku Yao and Han populations. Am J Hypertens 21:382–387
Ruskin RS, Priya K, Gopukumar S (2014) Evaluation of phytochemical, antibacterial and anti-cancerous activity of *Cissus quadrangularis* from South Western Ghats regions of India. Int J Pharm Sci Rev Res 28:12–15
Sahashi Y (2005) Herbs covered by health insurance in Japan. J Kampo Acupun Integr Med 1:70–84
Sánchez AM, Malagarie-Cazenave S, Olea N, Vara D, Chiloeches A, Díaz-Laviada I (2007) Apoptosis induced by capsaicin in prostate PC-3 cells involves ceramide accumulation, neutral sphingomyelinase, and JNK activation. Apoptosis 12:2013–2024
Sandhya T, Lathika K, Pandey B, Mishra K (2006) Potential of traditional ayurvedic formulation, Triphala, as a novel anticancer drug. Cancer Lett 231:206–214
Sandler A, Gray R, Perry MC, Brahmer J, Schiller JH, Dowlati A, Lilenbaum R, Johnson DH (2006) Paclitaxel–carboplatin alone or with bevacizumab for non–small-cell lung cancer. N Engl J Med 355:2542–2550
Saper RB, Kales SN, Paquin J, Burns MJ, Eisenberg DM, Davis RB, Phillips RS (2004) Heavy metal content of ayurvedic herbal medicine products. JAMA 292:2868–2873
Sarfaraz S, Afaq F, Adhami VM, Mukhtar H (2005) Cannabinoid receptor as a novel target for the treatment of prostate cancer. Cancer Res 65:1635–1641
Scalbert A (1991) Antimicrobial properties of tannins. Phytochemistry 30:3875–3883
Scher HI, Kelly WK, Zhang ZF, Ouyang P, Sun M, Schwartz M, Ding C, Wang W, Horak ID, Kremer AB (1999) Post-therapy serum prostate-specific antigen level and survival in patients with androgen-independent prostate cancer. J Natl Cancer Inst 91:244–251

Seeram NP, Adams LS, Henning SM, Niu Y, Zhang Y, Nair MG, Heber D (2005) *In vitro* antiproliferative, apoptotic and antioxidant activities of punicalagin, ellagic acid and a total pomegranate tannin extract are enhanced in combination with other polyphenols as found in pomegranate juice. J Nutr Biochem 16:360–367

Sertel S, Eichhorn T, Plinkert PK, Efferth T (2011) Cytotoxicity of *Thymus vulgaris* essential oil towards human oral cavity squamous cell carcinoma. Anticancer Res 31:81–87

Setty AR, Sigal LH (2005) Herbal medications commonly used in the practice of rheumatology: mechanisms of action, efficacy, and side effects. Semin Arthritis Rheum 34:773–784

Shan SJ, Xiao T, Chen J, Geng SL, Li CP, Xu X, Hong Y, Ji C, Guo Y, Wei H, Liu W (2012) Kanglaite attenuates UVB-induced down-regulation of aquaporin-3 in cultured human skin keratinocytes. Int J Mol Med 29:625–629

Shareef M, Ashraf MA, Sarfraz M (2016) Natural cures for breast cancer treatment. Saudi Pharm J 24:233–240

Shibata S, Inoue H, Iwata S, Ma R, Yu L, Ueyama H, Takayasu J, Hasegawa T, Tokuda H, Nishino A, Nishino H (1991) Inhibitory effects of licochalcone A isolated from *Glycyrrhiza inflata* root on inflammatory ear edema and tumour promotion in mice. Planta Med 57:221–224

Shimada Y, Yoshino M, Wakui A, Nakao I, Futatsuki K, Sakata Y, Kambe M, Taguchi T, Ogawa N (1993) Phase II study of CPT-11, a new camptothecin derivative, in metastatic colorectal cancer. CPT-11 gastrointestinal cancer study group. J Clin Oncol 11:909–913

Shin HR, Kim JY, Yun TK, Morgan G, Vainio H (2000) The cancer-preventive potential of *Panax ginseng*: a review of human and experimental evidence. Cancer Causes Control 11:565–576

Shoskes DA (2002) Phytotherapy in chronic prostatitis. Urology 60:35–37

Sivakumar T, Nair BJ, Panicker A (2010) Phytochemicals-the natural fighters against oral cancer. Trivend Dental J 1:33–41

Slichenmyer WJ, Rowinsky EK, Donehower RC, Kaufmann SH (1993) The current status of camptothecin analogues as antitumor agents. J Natl Cancer Inst 85:271–291

Song HZ, Igarashi M, Kato M, Muto Y (2004) *In vitro* study of the chemopreventive effects of Chinese herbs against hepatocarcinogenesis. J Clin Biochem Nutr 35:1–5

Steigerová J, Oklešťková J, Levková M, Rárová L, Kolář Z, Strnad M (2010) Brassinosteroids cause cell cycle arrest and apoptosis of human breast cancer cells. Chem Biol Interact 188:487–496

Stoilova I, Krastanov A, Stoyanova A, Denev P, Gargova S (2007) Antioxidant activity of a ginger extract (*Zingiber officinale*). Food Chem 102:764–770

Swamy MK, Sinniah UR (2015) A comprehensive review on the phytochemical constituents and pharmacological activities of *Pogostemon cablin* Benth.: an aromatic medicinal plant of industrial importance. Molecules 20:8521–8547

Swamy MK, Sinniah UR (2016) Patchouli (*Pogostemon cablin* Benth.): botany, agrotechnology and biotechnological aspects. Ind Crop Prod 87:161–176

Swamy MK, Pokharen N, Dahal S, Anuradha M (2011) Phytochemical and antimicrobial studiesof leaf extract of *Euphorbia neriifolia*. J Med Plant Res 5:5785–5788

Swamy MK, Sinniah UR, Akhtar MS (2016) Antimicrobial properties of plant essential oils against human pathogens and their mode of action: an updated review. Evid Based Complement Alternat Med 22:1019. https://doi.org/10.3390/molecules22061019

Swamy MK, Arumugam G, Kaur R, Ghasemzadeh A, Yusoff MM, Sinniah UR (2017) GC-MS based metabolite profiling, antioxidant and antimicrobial properties of different solvent extracts of Malaysian *Plectranthus amboinicus* leaves. Evid Based Complement Alternat Med 2017:10. https://doi.org/10.1155/2017/1517683

Tacklind J, MacDonald R, Rutks I, Stanke JU, Wilt TJ (2012) *Serenoa repens* for benign prostatic hyperplasia. Cochrane Database Syst Rev 12:CD001423. https://doi.org/10.1002/14651858.CD001423.pub3

Takeo T (2015) Green tea polyphenol as food additive and supplemental factor for disease prevention. Int J Tea Sci 2:27–33

Takimoto CH, Wright J, Arbuck SG (1998) Clinical applications of the camptothecins. Biochim Biophys Acta 1400:107–119

Vaes LP, Chyka PA (2000) Interactions of warfarin with garlic, ginger, ginkgo, or ginseng: nature of the evidence. Ann Pharmacother 34:1478–1482
Valko M, Rhodes C, Moncol J, Izakovic M, Mazur M (2006) Free radicals, metals and antioxidants in oxidative stress-induced cancer. Chem Biol Interact 160:1–40
Varalakshmi B, Anand AV, Karpagam T, Bai JS, Manikandan R (2014) *In vitro* antimicrobial and anticancer activity of *Cinnamomum zeylanicum* Linn bark extracts. Int J Pharm Pharm Sci 6:12–18
Vavrečková C, Gawlik I, Müller K (1996) Benzophenanthridine alkaloids of *Chelidonium majus*; I. Inhibition of 5-and 12-lipoxygenase by a non-redox mechanism. Planta Med 62:397–401
Vidal S, Courcoux P, Francis L, Kwiatkowski M, Gawel R, Williams P, Waters E, Cheynier V (2004) Use of an experimental design approach for evaluation of key wine components on mouth-feel perception. Food Qual Prefer 15:209–217
Volkow ND, Baler RD, Compton WM, Weiss SR (2014) Adverse health effects of marijuana use. N Engl J Med 370:2219–2227
Waffo-Téguo P, Hawthorne ME, Cuendet M, Mérillon JM, Kinghorn AD, Pezzuto JM, Mehta RG (2001) Potential cancer-chemopreventive activities of wine stilbenoids and flavans extracted from grape (*Vitis vinifera*) cell cultures. Nutri Cancer 40:173–179
Wall ME, Wani M, Cook C, Palmer KH, McPhail AT, Sim G (1966) Plant antitumor agents. I. The isolation and structure of camptothecin, a novel alkaloidal leukemia and tumor inhibitor from *Camptotheca acuminata1*, 2. J Am Chem Soc 88:3888–3890
Wang H, Provan GJ, Helliwell K (2000) Tea flavonoids: their functions, utilisation and analysis. Trends Food Sci Technol 11:152–160
Wang X, Zhang H, Chen L, Shan L, Fan G, Gao X (2013) Liquorice, a unique "guide drug" of traditional Chinese medicine: a review of its role in drug interactions. J Ethnopharmacol 150:781–790
Wani MC, Taylor HL (1971) Plant antitumor agents. VI. The isolation and structure of taxol, a novel antileukemia and antitumor agent from [the stem bark of] *Taxus brevifolia*. J Am Chem Soc 93:2325–2327
Westfall RE (2001) Herbal medicine in pregnancy and childbirth. Adv Ther 18:47–55
WHO (2014) Global status report on noncommunicable diseases 2014. World Health Organization, Geneva. www.who.int/nmh/publications/ncd-status-report-2014/en/
WHO (2017) Cancer fact sheet. http://www.who.int/mediacentre/factsheets/fs297/en/. Accessed 17 July 2017
Witherup KM, Look SA, Stasko MW, Ghiorzi TJ, Muschik GM, Cragg GM (1989) *Taxus* spp. needles contain amounts of taxol comparable to the bark of *Taxus brevifolia*: analysis and isolation. J Nat Prod 53:1249–1255
Wong BY, Lau BH, Jia TY, Wan CP (1996) *Oldenlandia diffusa* and *Scutellaria barbata* augment macrophage oxidative burst and inhibit tumor growth. Cancer Biother Radiopharm 11:51–56
Wongnoppavich A, Jaijoi K, Sireeratawong S (2009) Triphala: the Thai traditional herbal formulation for cancer treatment. Songklanakarin J Sci Technol 31:139–149
Wu Y, Fischer W (1997) Practical therapeutics of traditional Chinese medicine. Paradigm Publications, Brookline
Wu AH, Yu MC, Tseng CC, Hankin J, Pike MC (2003) Green tea and risk of breast cancer in Asian Americans. Int J Cancer 106:574–579
Yager P, Domingo GJ, Gerdes J (2008) Point-of-care diagnostics for global health. Annu Rev Biomed Eng 10:107–144
Yang YW, Bian HM, Jiang FR (2009) Lung cancer and traditional Chinese medicine therapy. Chin Arch Tradit Chin Med 9:065
Yoshida Y, Wang M, Liu J, Shan B, Yamashita U (1997) Immunomodulating activity of Chinese medicinal herbs and *Oldenlandia diffusa* in particular. Int Immunopharmacol 19:359–370
You Li H (2010) Resource and utilization of medicinal plant of the genus *Adenophora* in Qinling mountains. Med Plant 1:3–6
Zaveri NT (2006) Green tea and its polyphenolic catechins: medicinal uses in cancer and noncancer applications. Life Sci 78:2073–2080

Zeng Y, Li Y, Yang J, Pu X, Du J, Yang X, Yang T, Yang S (2017) Therapeutic role of functional components in alliums for preventive chronic disease in human being. Evid Based Complement Alternat Med 2017:9402849. https://doi.org/10.1155/2017/9402849

Zhan YP, Huang XE, Cao J, Lu YY, Wu XY, Liu J, Xu X, Xiang J, Ye LH (2012) Clinical safety and efficacy of Kanglaite® (Coix seed oil) injection combined with chemotherapy in treating patients with gastric cancer. Asian Pac J Cancer Prev 13:5319–5321

Zhang M, Holman CAJ, Huang J-P, Xie X (2007) Green tea and the prevention of breast cancer: a case–control study in Southeast China. Carcinogenesis 28:1074–1078

Zhu L, Yang Z, Wang S, Tang Y (2009) Kanglaite for treating advanced non-small-cell lung cancer: a systematic review. Chin J Lung Cancer 12:208–215