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Review Article

A REVIEW ON POTENTIAL USES OF CULINARY VEGETABLES USED IN ROUTINE LIFE AS AN ANTICANCER AGENT

LAVANYA B, JAYASHREE V*, JEEVARAJ S

Department of Pharmacology, School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Sciences, Pallavaram, Chennai – 600 117, Tamil Nadu, India. Email: mailtovjayashree@gmail.com

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ABSTRACT

Cancer is a disease which leads to death, and chemotherapy is a treatment used to treat cancer. Lung cancer and breast cancer are most effective one in the world. The present study examines the anticancer property of culinary vegetables such as *Allium* vegetables, cruciferous vegetables, and beetroot which are used in day-to-day life have anticancer properties. Allicin and gallic acid in garlic decreases the risk of colon, pancreas, stomach, esophagus, and breast cancers. In onion, cysteine sulfoxide is sulfur compounds which have ant-cancer, antiplatelet, and antithrombotic property. In broccoli, glucosinolates and sulfur compounds play a major role in the treatment of breast and prostate cancer. Betacyanin is a compound present in beetroot which has antioxidant property and anticancer activity.

Keywords: Anticancer, Gallic acid, Cysteine sulfoxide, Glucosinolates, Betacyanin.

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INTRODUCTION

Cancer is deadly disease that involves abnormal cell growth and spread to other parts of the body [1]. Cancer is not only one disease but also a group of more than 100 distinct disorders [2]. It is the second leading cause of mortality in the world, and chemotherapy is the main modalities available for cancer treatment. However, recently, chemotherapeutic drugs which are available in the market are reported to exhibit toxicity toward normal tissues and possess undesirable side effects [3]. Cancer influences any race, any age group, or societal class and disseminated all around the world that leads to significant loss of human lives. Statistics indicates that men are mostly suffered from lung, colon, rectum, and prostate cancer, while women increasingly suffer from breast, colon, rectal, and stomach cancer [4]. Two types of tumors are benign tumor (non-cancerous) and malignant tumor (cancerous). Most common type of cancer includes lung cancer, breast cancer, liver cancer, stomach cancer, and colorectal cancer.

Cancers are classified by the tumor cells and are made up of special type of cells. These include carcinoma (tumors derived from the epithelial cells of the body organs), sarcoma (tumors arise from the connective tissue such as bone, cartilages, fat, and nerve), lymphoma/leukemia (tumors arise from blood-forming cells), germ cell tumor (tumors derived from pluripotent cells and germ cells present in the testicle or ovary), and blastoma (tumors derived from the immature precursors cells) [5].

Cancer-fighting vegetables include *Allium* vegetables (garlic, leeks, and yellow and green onions), cruciferous vegetables (broccoli, brussels sprouts, cauliflower, kale, red cabbage, and curly cabbage), spinach, and beet root also scored in the top ten against many of the cancers tested.

GARLIC (*ALLIUM SATIVUM*)

Garlic (*A. sativum* L.) belongs to family Amaryllidaceae, and it is also called as poor man's treacle. The garlic bulb consists of more than 200 chemical compounds, such as volatile oil with sulfur-containing compounds, namely ajoene (4,5,9-trithiadodeca-1,6,11-triene-9-oxide), alliin, and allicin, enzymes, namely peroxidase, alliinase, and myrosinase and other compounds like -phellandrene, - phellandrene, linalool, citral and geraniol are important [6].

Garlic acts as insecticidal, antimicrobial, antiprotozoal, and antitumor activity [7,8]. Epidemiological and experimental studies explain that garlic is a potent vegetable for the prevention of cancer. The anticancer effect of garlic has been reported to exhibit the anticancer effect through their anticarcinogenic, antimutagenic, and antitumor properties by fresh extract, powder, oil of garlic, and several organosulfur compounds derived from garlic. The mechanism of action was found to be inhibition of carcinogen activation, boost phase 2 detoxifying processes, cell cycle arrest of malignant cells mostly in G2/M phases, stimulation of the mitochondrial apoptotic pathway, and an increase of histone acetylation [9,10]. The main components of garlic are amino acids (glutaminic acid, arginine, aspartic acid, leucine, lysine, and valine) [11], gallic acid such as polyphenolic compounds, minerals (manganese, potassium, calcium, and phosphorus and in minor quantities: Magnesium, selenium, sodium, iron, zinc, and copper), vitamins (Vitamin B6 and also Vitamin C and in minor quantities, folic acid, panthotenic acid, and niacin), essential oil with many sulphur-containing components (allyldisulfide and allyltrisulfide), Alliin, Ajoene, quercetin, and sugars (fructose and glucose) [12,13]. The fibrinolytic activity of garlic in both man and experimental animals has been reported. Many claims have been done on garlic for antibiotic action, hypoglycemic effect, antitumor, antioxidant, and antithrombotic properties [14-17] and have also been attributed to the garlic extracts.

Anticancer activity of garlic

Allicin is one of the most important predecessor of bioactive compounds of garlic. A number of population studies demonstrated a relationship between excess garlic intake and reduction in risks of pancreas, colon, stomach, esophagus, and breast cancers [18]. The organosulfur compounds derived from garlic have been reported to exhibit the anticancer effect through their anticarcinogenic, antimutagenic, and antitumor properties. Recently, studies shown that sativum lectin 50 (ASL50, 50 kDa) isolated from *A. sativum* exhibited antiproliferative activity on oral carcinoma KB cells and induces 2.5-fold higher caspase enzyme activity than untreated cells [19].

Anticarcinogenic activity of garlic is also thought to be due to the modulation of carcinogen metabolism. The cell cycle arrest by diallyldisulfides (DADS) in human colorectal tumor cell line, HCT-15,

has been reported. DADS decreased cells in G1 phase and, in turn, increased cells in G2/M phase [20]. The mechanism of cell cycle arrest by diallyltrisulfides (DATS) at G2/M phase was studied using human prostate cancer cells, PC-3 and DU145 and it was closely associated with reactive oxygen species. The cell cycle arrest by DATS at G2/M phase in prostate cancer cells was associated with reactive oxygen species. The cell cycle arrest with DATS appeared to be selective for cancer cells since a normal prostate epithelial cell line was resistant to cell cycle arrest with DATS [21].

Gallic acid is a polyphenol compound and has been reported for its antiproliferative activity against many cancer cell lines [22]. Prevention of cancer by organosulfur compounds from garlic has been studied in a medium-term bioassay system (Ito assay) to detect liver carcinogens and promoters in rats [23]. In these studies, attention was focused on soluble organosulfur compound chemoprevention in the post-initiation phase of cancer development. In addition, the modifying effects of S-methyl and cysteine on the initiation stage of rat hepatocarcinogenesis were investigated [24].

ONION (*ALLIUM CEPA* L.)

The onion is one of the most valuable vegetables. Onions have anticancer properties, antiplatelet activity, antithrombotic activity, and antibiotic effects. These benefits are mainly associated with sulfur compounds called cysteine sulfoxides [25]. The phytochemical research has proved that onion is rich in flavonols and organosulfur compounds, which have exhibited tumor inhibitory properties in laboratory studies [26]. Higher onion intake was decrease the risk of breast cancer. Onion is well known for its benefits to weight control and cancer prevention.

Anticancer activity of onion

Onions are an important source of several phytonutrients as flavonoids, fructooligosaccharides (FOS), and thiosulfonates and other sulfur compounds [27]. Flavonoids are the major phenolics in onions, and some flavonoids are flavones, flavanones, flavonols, isoflavones, flavanonols, flavanols, chalcones, and anthocyanins [28]. Flavonols are the most abundant in onions, present as their glycosides, i.e., quercetin and kaempferol [29]. The sulfur-containing compounds present in onion are S-alk(en)yl-L-cysteine sulfoxides [30].

The epidemiological studies proved that garlic, onions, and related *Allium* vegetables was used for the prevention of cancers of gastrointestinal tract such as stomach cancer, colorectal cancer, and to some extent esophageal cancers. Mechanism involves alteration of the biological behavior of tumors, tumor microenvironments, or precancerous cells, and the way it decreases cancer risk [31].

Anticancer and antibacterial activity has been proved in the lacto-fermented of onion extracts. In some research, a good correlation between the flavonoid contents of onions and cytotoxic or antibacterial activity have been proved, and, hence data demonstrated that lacto-fermented onions are used against breast cancer cells [32].

BROCCOLI (*BRASSICA OLERACEA* L.)

Cruciferous vegetables such as cauliflower and broccoli are the most consumed vegetables [33]. Cruciferous are known to possess antioxidant activity [34]. Bioactive phytochemicals such as glucosinolates, phenolic compounds, Vitamin C, and mineral nutrient are present in broccoli [35]. They play a role in the prevention of chronic diseases, breast, and prostate cancer [36,37].

Broccoli (B. oleracea L.) has been marketed as a health-promoting food because it naturally has high content of bioactive phytochemicals such as glucosinolates, phenolic compounds, Vitamin C, and mineral nutrients. Broccoli has also been found to exhibit antioxidant activity that prevents oxidative stress related to many diseases. Various epidemiologic studies have indicated that consumption of broccoli is associated with a lower risk of cancer, including breast, prostate, lung, stomach, and colon cancers [38-40]. The anticancer effect of broccoli has been attributed to sulforaphane (SFN), an isothiocyanate formed by hydrolysis of a precursor glucosinolate called "glucoraphanin." Although glucoraphanin [41] is found in varying amounts in all cruciferous vegetables, the highest concentration of this compound is found in broccoli and its sprouts [42].

Anticancer effect of broccoli

SFN suppresses the expression of multidrug resistance protein, reduced drug efflux, and increased anticancer activity. In subcutaneous tumor model of Barrett esophageal adenocarcinoma, a significant decrease in tumor volume was also observed. The anticancer activity was mainly due to the induction of caspase 8 and p21 and down-regulation of hsp90, a molecular chaperone required for the activity of several proliferation-associated proteins. It also shown that bread enriched with broccoli sprouts was found to be effective against stomach cancer [43]. Furthermore, the effect on *in vitro* proliferation and motility of stomach cancer cells differing in metastatic potential were studied. Thus, these studies indicate that broccoli sprouts may serve as a valuable food supplement preventing upper gastrointestinal system.

BEETROOT (*BETA VULGARIS* L.)

Beetroot is a vegetable plant and belongs to family Amaranthaceae. The roots of beet have used in traditional Arab medicine to treat a wide variety of diseases. The claimed therapeutic use of beetroot includes its antitumor, carminative, emmenagogue, and hemostatic and renal protective properties and is a potential herb used in cardiovascular conditions. It consists of chemical compounds such sa betalain, betacyanins, betanin, and betaxanthine. They also have carotenoids, glycine betaine, saponins, betacyanines, betanin, polyphenols, and flavonoids.

Beetroot possesses antihypertensive, hypoglycemic, antioxidant [44], anti-inflammatory, and hepatoprotective activities [45-48].

In beetroot, the betacyanin is a chemical constituent which is responsible for red beet color, and it is an antioxidant with modulator of oxidative stress. Research area is mainly focused on anticancer activities of beetroot extract, and in animal models, has unravelled their potential benefits as chemopreventive and chemotherapeutic agents [49].

Anticancer activity of beetroot

Treatment of ethanolic extract of beetroot reduced the amount of cleaved caspase 3 and Bax and protein expression and increased the Bcl-2 protein expression [50]. Cyanidin-3-O-glucoside chloride had growth inhibitory activities against the human colon (CACO-2), hepatocellular (HepG2), and breast (MCF-7) carcinoma cell lines, respectively [51].

CONCLUSION

For centuries, Allium vegetables have been used in a wide variety of cuisines worldwide and are valued for their potential medicinal properties. During the first Olympic Games in Greece, garlic was consumed as a stimulant, and in Roman times, soldiers chewed garlic before battle for strength. At present, these vegetables continue to hold their fascination for their unique flavor, chemistry, and biological properties. Epidemiological studies indicate that consumption of Allium vegetables was protective against cancers, particularly GIT cancer.

Garlic-derived components play major roles to protect cells from the mutation and to prevent the undifferentiated cell growth. Thus, the daily consumption of garlic may contribute to prevent cancer. As onion is rich in flavonols and organosulfur compounds, its higher intake decreases the risk of breast cancer and it is also well-known for its benefits to weight control and cancer prevention.

Broccoli by-products such as leaves and stems contain high total phenolics, and hence, it shows high antioxidant and anticancer activities. Thus, these by-products can be used as functional food ingredients in the food industry. Beetroot is rich in carotenoids and polyphenols, and it shows good antitumor, carminative, emmenagogue, and hemostatic and renal protective properties.

CONFLICTS OF INTEREST

No conflict to disclose.

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