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Anticancerous properties of cruciferous vegetables

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Abstract

Cancer is a group of diseases in which there is abnormal growth of cells in the body with the ability to spread to other parts of the body. Consumption of fruits and vegetables in our daily diet is associated with reduced risk for many of the common cancers. There is a strong evidence of reduced risk of mouth and pharynx, esophagus, lung, stomach, and colon by consuming fruit and vegetables daily. Like other vegetables, cruciferous vegetables contain a number of nutrients and phytochemicals with cancer chemopreventive properties, including folate, fibre, carotenoids and chlorophyll. However, cruciferous vegetables are unique in that they are rich sources of glucosinolates, sulfur-containing compounds that are responsible for their pungent aromas and bitter taste. Glucosinolates are the major class of secondry metabolites found in brassica crops. The most important glucosinolates found in brassica vegetables are methionine derived glucosinolates. Many organizations, including the National Cancer Institute, recommend the consumption of 5–9 servings (2½–4 ½ cups) of fruits and vegetables daily, but separate recommendations for cruciferous vegetables have not been established. Compounds such as sulforaphane may help to prevent cancer by increasing the elimination of potential carcinogens from the body and increasing the transcription of tumor suppressor proteins. Glucosinolates are present in relatively high concentrations in cruciferous vegetables, but cooking, particularly boiling and microwaving at high power, may decrease the bioavailability of isothiocyanates.

Cancer is a group of diseases in which there is abnormal growth of cells in the body with the ability to spread to other parts of the body. According to a statistics, in 2012, there were 14 million new cases and 8.2 million cancer-related deaths worldwide. The number of new cancer cases will rise to 22 million within the next two decades. This problem is more prevalent in developed countries than the developing countries and this is due to huge pollution and overuse of pesticides in the agriculture community. Many cancers can be prevented by not smoking, maintaining a healthy weight, not drinking too much alcohol, eating plenty of vegetables, fruits and whole grains, vaccination against certain infectious diseases, not eating too much processed and red meat, and avoiding too much sunlight exposure. Consumption of fruits and vegetables in our daily diet is associated with reduced risk for many of the common cancers. There is a strong evidence of reduced risk of mouth and pharynx, esophagus, lung, stomach, and colon by consuming fruit and vegetables daily. Available scientific evidence suggests that some components of fruits and vegetables inhibit cancer therefore studies have been done to identify such components in fruits and vegetables.

Cruciferous vegetables belongs to family *Brassicaceae*. Vegetables like broccoli, brussels sprouts, cabbage, cauliflower, collard greens, kale, kohlrabi, mustard, rutabaga, turnips, bok choy and chinese cabbage are some of the common vegetables of this family. Like other vegetables, cruciferous vegetables contain a number of nutrients and phytochemicals with cancer chemopreventive properties, including folate, fibre, carotenoids and chlorophyll. However, cruciferous vegetables are unique in that they are rich sources of glucosinolates, sulfur-containing compounds that are responsible for their pungent aromas and bitter taste (Drewnowski and Gomez-Carneros, 2000). The hydrolysis of glucosinolates by the plant enzyme myrosinase results in the formation of biologically active compounds, including indoles and isothiocyanates (Holst and Williamson, 2004). For example, broccoli is a good source of glucoraphanin, the glucosinolate precursor of sulforaphane, and glucobrassicin.

Compounds having anticancer properties : To get a optimal health, constant supply of phytochemicals is must and therefore vegetables are the necessary part of daily diet. So, with this context cabbage and kale are becoming more popular among consumers because of their nutritional value and anti-cancer properties. *Brassica* vegetables contain high amounts of calcium, carotene, vitamin C and Vitamin E. They are also rich in total antioxidants (Nilsson *et al.*, 2006). In the past decade much attention have been given to the positive effects of glucosinolates (phytochemicals), whose breakdown products are reported to carry anti-cancer properties. Glucosinolates are the major class of secondry metabolites found in brassica crops. The most important glucosinolates found in brassica

vegetables are methionine derived glucosinolates (Mithen *et al.,* 2003) Sinigrin, glucobrassicin and glucoeberin have been identified as the major glucosinolates in these crops, with sinigrin making the major contribution of glucosinolates in kales while glucobrassicin and glucoeberin do so in cabbage leaves.

When the tissue is damaged the glucosinolates get hydrolyzed to various bioactive products by endogenous plant enzyme myrosinase. The breakdown products include isothiocynates, thiocynates, epithonitriles oxazolidine and nitriles. Isothionates have different potential in cancer chemoprevention. Sulforaphane, the isothiocynate derived from glucoraphanin found in broccoli, has been the object of numerous studies (Farnham *et al.,* 2004). Sulforaphen and other isothiocynates may prevent tumor growth by blocking the cell cycle and promoting apoptosis. Principle glucosinolates found in white cabbage are sinigrin, glucoeberin, glucobrassicin: in savoy cabbage sinigrin, glucoeberin, glucobrassicin and progoitrin are found and in red cabbage sinigrin, glucoeberin, progoitrin, gluconapin and glucoraphanin are found.

Role of cruciferous vegetables in various types of cancer : Cruciferous vegetables are good sources of a variety of nutrients and phytochemicals that help prevent cancer. The control of lung cancer by consuming cruciferous vegetables is small compared with the benefit of smoking cessation. In a number of studies it have been found that people diagnosed with lung cancer had significantly lower intakes of cruciferous vegetables than people in cancer-free control groups. However, it may vary among people because genetic variation affecting the metabolism of glucosinolate hydrolysis products may influence the effect of consumption of these vegetables.

High cruciferous vegetable intake might decrease colorectal cancer risk by enhancing the elimination of dietary heterocyclic amine carcinogens. However, the protective effects of cruciferous vegetable consumption may be influenced by inherited differences in the capacity of individuals to metabolize and eliminate glucosinolate hydrolysis products. A small clinical trial found that the consumption of 250 g/d (9 oz/d) of broccoli and 250 g/d of Brussels sprouts significantly increased the urinary excretion of a potential carcinogen found in well-done meat, namely 2-amino-1-methyl-6-phenylimidazo [4,5-*b*] pyridine (Walters *et al.,* 2004).

The endogenous estrogen 17β-estradiol is highly estrogenic and has been found to enhance the proliferation of estrogen-sensitive breast cancer cells in culture. In a small clinical trial, increasing cruciferous vegetable intake of healthy postmenopausal women for four weeks can shift estrogen metabolism. It has been hypothesized that shifting estrogen metabolism could decrease the risk of estrogen-sensitive cancers, such as breast cancer (Bradlow *et al.,* 1996).

Glucosinolate hydrolysis products have been found to inhibit growth and promote death (apoptosis) of cultured prostate cancer cells. Chewing of raw cruciferous vegetables increases glucosinolate contact with plant myrosinase and increases the amount of isothiocyanates absorbed. Even when plant myrosinase is completely inactivated by heat, the myrosinase activity of human intestinal bacteria allows for some formation and absorption of isothiocyanates. These compounds promote death of prostate cancer cells.

Scientists have claimed that a pill made from broccoli extract could prevent tens of thousands of stroke deaths each year. Studies suggest the impact of a stroke could be significantly reduced by sulforaphane – which is released when lightly cooked broccoli is eaten. Researchers are now investigating whether a simple supplement containing the equivalent of three to five weekly portions of sulforaphane rich vegetables could prevent potentially deadly brain bleeds. A breakthrough study, funded by the British Heart Foundation, is under way and could see a widely available therapy within five years. Experts think a daily pill could lessen the damage should someone suffer a stroke and make inroads into cutting the 40,000 deaths every year.

Recommendations : Many organizations, including the National Cancer Institute, have recommended the consumption of 5–9 servings (2½–4½ cups) of fruits and vegetables daily, separate recommendations for cruciferous vegetables have not been established yet. Results of some prospective cohort studies suggest that adults should aim for at least 5 weekly servings of cruciferous vegetables (Willett, 1998).

Glucosinolates are water-soluble compounds that may leached out with cooking water. There is 18-59 % decrease in the total glucosinolate content of cruciferous vegetables if boiled for 9–15 minutes. So, use of cooking method, such as steaming or microwaving, is suggested as it leads to reduced glucosinolate losses. Boiling, steaming and microwaving at high power (850–900 watts) can inactivate myrosinase, the enzyme that catalyzes glucosinolate hydrolysis which decreases the bioavailability of isothiocyanates.

Conclusion: Cruciferous vegetables like broccoli, cabbage, cauliflower, kale, knol khol, brussels sprouts etc.

are part of our daily diet these days. Consumers are beware of the anticancerous properties of these vegetables. Cruciferous vegetables are rich sources of sulfur-containing compounds known as glucosinolates. Chopping or chewing cruciferous vegetables results in glucosinolate hydrolysis products, such as isothiocyanates and indole-3-carbinol. High intake of cruciferous vegetables has been associated with lower risk of lung and colorectal cancer but variation in genetic polymorphisms may influence the effectiveness of cruciferous vegetables on human cancer risk. Many organizations, including the National Cancer Institute, recommend the consumption of 5–9 servings (2½–4 ½ cups) of fruits and vegetables daily, but separate recommendations for cruciferous vegetables have not been established. Compounds such as sulforaphane may help to prevent cancer by increasing the elimination of potential carcinogens from the body and increasing the transcription of tumor suppressor proteins. Glucosinolates are present in relatively high concentrations in cruciferous vegetables, but cooking, particularly boiling and microwaving at high power, may decrease the bioavailability of isothiocyanates.

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