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A REVIEW

Role of Nutraceutical Enriched Broccoli in the Management of Lifestyle Diseases

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ABSTRACT : The new lifestyle diseases constitute a dual burden the existing problems of undernutrition are persisting while the problem of over nutrition are leading a sharp rise in the incidence of non- communicable lifestyle diseases. There is need to assess to a variety of affordable micronutrient rich greens and vegetables. People ingest a vast diversity of pharmacologically active chemicals in the form of foods. Obtaining vegetables and fruits with enhanced nutritional and medicinal qualities will become a much larger component of private and public breeding programs. Brassica vegetables contain glucosinolates, the metabolic breakdown products of which are potent modulators of xenobiotic- metabolising enzymes that protect DNA from damage.This protective effect has been linked to the presence of glucosinolates in these vegetables. Cruciferous vegetables are an excellent dietary source of phytochemicals including glucosinolates. phenolics and other antioxidants like vitamins like C, K and E as well as dietary essential minerals like Ca, Mg, Na, K, Fe, Zn. Dietary antioxidants (*i.e.* vitamins, flavonoids) present in broccoli may decrease the risk of certain diseases; like diabetes, cardiovascular diseases, hypertension, cancers, macular degeneration, neurological conditions, rheumatoid arthritis, Helicobacter pylon infection. Glucoraphanin is a glucosinolate found in high concentrations in the Mariner variety of broccoli (Brassica oleracea italica) and other members of the Brassica family. Sulforaphane is the biologically active isothiocyanate produced when glucoraphanin is metabolized by the enzyme myrosinase. Sulforaphane's also has anti-inflammatory effects, inhibits the production of interleukin and tumor necrosis factor-alpha (TNF-x) in rheumatoid T cells. Sulforaphane exhibits broad-spectrum antimicrobial activity, inhibiting the growth of several gram-positive and —negative bacteria.

Key Words :
Brassica, Glucosinolates, Phenolics, Antioxidants, vitamins, Tumor necrosis factor-alpha (TNF-x), Sulforaphane

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The commercial success of functional foods has led to intense interest in the discovery and the characterization of plant based bioactive compounds. Consumption of Brassica vegetables such as broccoli, cabbage, brussel sprouts and cauliflower, belonging to crucifers provide modest support for the hypothesis that their high intakes reduce the risk of degenerative disorders such as cancer of all types and cardiovascular diseases. Broccoli is known as the "Crown Jewel of Nutrition" since it posses all the nutrients namely vitamins, minerals, secondary metabolites and fiber proclaiming its exceptional health benefits. The breakdown products of the sulfur containing glucosinolates, isothiocyanates are the active principles in exhibiting the anticancer property at every stage. Broccoli is a member of the cabbage family, and is closely related to cauliflower. Its cultivation originated in Italy. Broccolo, its Italian name, means "cabbage sprout." Broccoli's name is derived from the Latin word brachium, which means branch or arm, a reflection of its tree-like shape that features a compact head of florets attached by small stems to a larger stalk. The cruciferous vegetables which include broccoli, cabbage and cauliflower are excellent source of phytochemicals including glucosinolates and their byproducts, phenolics and antioxidant vitamins as well as dietary minerals. The medicinal properties of broccoli consumption are most likely mediated through these bioactive compounds by inducing a variety of functions including acting as antioxidants, regulating enzymes and controlling. apoptosis and cell cycle (Comblatt *et al.*, 2007, Gill *et al.*, 2004, Michand *et al.*, 1999, Parnaud *et al.*, 2004, Branchi *et al.*, 2005 and Jackson *et al.*, 2004). The purpose of this review is to provide evidence how the phytoconstituents of broccoli are helpful to use it as a preventive medicinal food for the maintenance of health and the mechanism behind the same.

Nutritive constituents of broccoli floret and leaves:

Broccoli has been reported as the one of main sources of natural antioxidants *i.e.*, phenolic compounds and vitamins and chemopreventive compounds *i.e.*, glucosinolates and their degradation products, isothiocyanates (Olga *et al.*, 2009). The organosulfur chemicals namely glucosinolates and the S methyl cysteine sulphoxide found in broccoli in concert with other constituents such as vitamins E, C, K and the minerals such as iron, zinc, selenium and the polyphenols namely kaempferol, quercetin glucosides and isorhamnetin are presumably responsible for various health benefits of broccoli (Hannah *et al.*, 2009).

Green leafy vegetables are a rich source of minerals (iron, calcium, potassium, and magnesium) and vitamins, including vitamin K, C, E, and many of the B vitamins. They also provide a variety of phytonutrients. There are many varieties of green leafy vegetables which are rich in micronutrients, but are usually discarded or not used for human consumption. Broccoli leaves are one of them, which are available at no cost and is rich in all the macronutrient. It is an exceptionally nutritious vegetable with a variety of potential uses. According to FAO, India produces approx 5,014,500 tonnes of broccoli annually, out of which leaves contribute 50 percent of the total production. In the field, up to 70% of the total weight of the broccoli plant is discarded, generating high quantities of florets, leaves and stalks as crop remains. These materials are often regarded as crop remains and a small percentage is used without treatment in animal feed. Recently, recovery and bioconversion of vegetables residues to high-value compounds has been receiving great attention (Mahro and Timm, 2007).

Fresh broccoli leaves are exceptionally rich source of vitamin which is a powerful natural antioxidant and immune modulator, helps fight against flu, causing virus. Broccoli leaves contain very good amount of another antiQxidant vitamin, vitamin-A, it helps maintain integrity of skin and mucus membranes is also required for vision.

Owing to high moisture content, green leafy vegetables are considered concentrated source of nutrients, addition of small amount of these dehydrated leaves in various preparations could be of immense value to combat micronutrient deficiency. The leaves of broccoli are available only for a short period but these can be dried and then stored for use during lean season (Kowsalaya and Vidhay, 2004). A great deal of research on functional foods like anticarcinogens has focused on broccoli and on a single bioactive component within broccoli, sulphoraphane. Some researchers have concluded that the evidence for health benefits from sulpharaphane is strong enough to warrant product development and broccoli sprouts with a uniformly high concentration of sulphoraphane are a patented, commercially available product (Moreno *et al.*, 2006). Any process that disrupts cellular integrity may result in a hydrolysis of glucosinolates caused by myrosinase activity. Myrosinase (B-thioglucosidase) is an enzyme naturally present in plants which are able to synthesize glucosinolates, and when mixed with glucosinolates the hydrolysis occurs. Hydrolysis of glucosinolates can also occur during harvesting and storage caused by senescence, especially in vegetables with a shorter shelf-life such as broccoli and cauliflower. Among the breakdown products of glucosinolates, isothiocyanates and indoles in particular have been implicated to have anticarcinogenic properties (J-alkier & Gershenzon, 2006). Sulforaphane is one of the most investigated isothiocyanates, which is formed from it corresponding glucosinolate glucoraphanin reported to be present in broccoli in greater quantity (Fhey *et al.*, 2001). Indole degradation products including indole-3-carbinol, especially known for its cancer-preventive effects in reproductive organs, are formed from glucosinolates synthesized from tryptophan (Gal-ikapaty *et al.*, 2005). Losses of glucosinolates and their breakdown products can occur during cooking, blanching, steaming and other ways of domestic food preparation, as well as during industrial vegetable processing such as dehydration.

Broccoli is a good vegetable source of major mineral elements such as sodium, potassium,calcium,magnesium, Chlorine, Phosphorus and selenium and trace elements such as iron, Zinc, Copper, Magnese and Selenium for hutuan nutrition (House *et al.*, 1999) and studies have shown that broccoli is an important alternative source of Ca in segments of the population that consume limited amounts of dairy products (Farnhan *et al.*, 2000). In a study on the use of composted sewage sludge as horticultural growth media, it was identified that broccoli roots have good micronutrient extraction efficiency from composted sewage sludge rich in Fe, Cu, Mn, and Zn. However, heavy metal accumulation such as Cd and Pb were low in relation to micronutrients (Dolores *et al.*, 2005). Chromium a micronutrient exhibiting lot of health benefits is present in broccoli to the level of 12 µg/100gm (Cefalu William *et al.*, 2004, Kovacs al 2007).

Sulforaphane is the biologically active isothiocyanate produced when glucoraphanin is metabolized by the enzyme myrosinase (Mithen, 2001). Sulforaphane is found in highest concentrations in broccoli sprouts, but it is also found in mature broccoli and other cruciferous vegetables, such as cauliflower, cabbage, and kale. The studies suggest that Sulforaphane has the potential to reduce risk of various types of cancers, diabetes, atherosclerosis, respiratory diseases, neurodegenerative disorders, ocular disorders, and cardiovascular diseases. Traditionally, Nrf2-mediated induction of phase 2 detoxification enzymes has been recognized as the major mechanism by which Sulforaphane protects cells (Faway and Nehad, 2011).

Research in humans indicates approximately 74 percent of sulforaphane from broccoli extract is absorbed in the jejunum (Petri *et al.,* 2003). After absorption, sulforaphane is metabolized via the mercapturic acid pathway(Kassahun *et al.*, 1997, KoIm *et al.,* 1995). Although this pathway involves a complex interplay between the liver, small intestine, and kidneys, the liver is thought to be the primary site of activity and is the site of sulforapharie conjugation to glutathione. Sulforaphane-glutathione conjugates are subsequently converted to cysteinyl-glycine, cysteine, and N-acetylcysteine conjugates in the kidneys or gut and then cycled back to the liver for acetylation. Of these conjugates, sulforaphane-N acetylcysteine is the most prevalent (Conaway *et al.,* 2002). Sulforaphane is considered by many to be responsible for the major part of cancer prevention by broccoli, at least in part by upregulating phase II detoxification enzymes that might clear chemical carcinogens and reactive oxygen species (ROS; Fahey *et al.,* 1997).

Broccoli is a significant source of flavonoids and phenolics such as caffeic and sinapic acids(Vallejo et al 2003). A large number of hydroxycinnamic acid esters of kaempferol and quercetin glucosides has been characterized in broccoli inflorescence. The antioxidant activity of phenolic compounds is due to their ability to scavenge free radicals, donate hydrogenatoms or electron, or chelate metal cations(Afanas'ev *et al.,* 1989, Amarowicz *et al.,* 2004). The structure of phenolic compounds is a key determinant of their radical scavenging and metal chelating activity, and this is referred to as structure—activity relationships (SAR). In the case of phenolic acids, the antioxidant activity depends on the numbers and positions of the hydroxyl groups in relation to the carboxyl functional group (Rice-Evans *et al.,*1996, Robards *et al.,* 1999).

Role of Broccoli in lifestlye diseases:

Role of Broccoli leaf and floret in lowering blood glucose:

Nowadays, no-drug treatments (medicinal plants) are novel therapeutic approaches in the treatment of\ diabetes. Diabetes is the most common endocrine disease being characterized with increased blood sugar (hyperglycemia) and disorders in metabolizing carbohydrates, lipids, and proteins. Broccoli is a plant in the cabbage family, whose large flower head is used as a vegetable. The mass of flower heads is surrounded by leaves. Researchers in different part of the world have indicated that broccoli possessed high antioxidant capacity (Ismet *et al.,* 2010). It has been reported that a compound sulforaphane was isolated and identified from broccoli. Sulforaphane is able to induce some enzymes, such as quinine reductase and glutathione S-transferases, to metabolize xenobiotics (Guo *et al.,* 2001) Sulphoraphane found in this cabbage protects from bacteria, cancer and diabetes. Broccoli is a nutritious food and it is a good source of vitamin and minerals. It prevents certain types of cancer, diabetes, heart disease, osteoporosis, Alzheimers disease, joint inflammation and high blood pressure. Diabetic micro- and macro-vascular diseases are associated with dysfunction of the endothelial cells in hyperglycemia. Oxidative stress and formation of reactive oxygen species by mitochondria are common features in the endothelial cell dysfunction in hyperglycemia (Nyengaard *et al.,* 2004). When incubated with human microvascular endothelial cells under low and high glucose concentrations, sulphoraphne resulted in activation of Nrf2 and prevented the hyperglycemia-induced activation of hexosamine and protein kinase C (PKC) and prevented increased cellular accumulation of the glycating agent methyiglyoxal. Sulforaphane is an activator of transcription factor NF-E2—related factor-2 (nrf2) that regulates gene expression through the promoter antioxidant response element (ARE). Nrf2 regulates the transcription of a battery of protective and metabolic enzymes. The aim of this study was to assess whether activation of nrf2 by sulforaphane in human microvascular endothelial cells prevents metabolic dysfunction in hyperglycemia (Xue *et al.,*, 2008). In another interesting study, pretreatment with Sulphoraphane blocked the development of type 1 diabetes in streptozotocin-treated mice and resulted in restoration of normal insulin secreting responses to glucose in cytokine-treated rat pancreatic islets (Song *et al.,* 2009). The antioxidative effect and protective potential against diabetes of the broccoli flower were investigated both in vitro and in a diabetic rat model. Protein oxidation, and nitric oxide generation by sodium nitroprusside. The in vitro results suggest that the BuOH fraction from the broccoli flower has a protective potential against oxidative stress (Cho *et al.,* 2006) Bhadoran *et al.,* 2010 conducted a new study on Eighty-one double-blind, placebo-controlled type 2 diabetic patients were randomized into three groups to receive one of the following: group A (BSP l0g/d, n26), group B (BSP 5g/d, n=29) and group C (placebo, n=26) for 4 weeks to check oxidative stress parameters in patients. Serum levels of FBS, lipids and lipoproteins were measured before and 4 weeks after intervention. Seventy-two subjects completed the follow up. They were concluded that administration of broccoli sprout powder for 4 weeks had favorable effects on fasting serum glucose and lipid profiles in type 2 diabetic patients. Hyperglycemia is also found to promote lipid per oxidation of low density lipoprotein (LDL) by a superoxide-dependent pathway resulting in the generation of free radicals. While on the one hand hyperglycemia engenders free radicals, on the other hand it also impairs the endogenous antioxidant defense system in many ways during diabetes. Antioxidant defense mechanisms involve both enzymatic and nonenzymatic strategies. An active ingredient in broccoli, known as sulforaphane, produces enzymes that protect blood vessels by reducing tissue damaging substances triggered by high blood sugar levels.Recently UK researchers reported that eating broccoli could reverse the damage done to heart blood vessels by diabetes. They confirmed the reversal of the biochemical dysfunction of endothelial cells in hyperglycemia by sulforaphane by activation of Nrf2 and related antioxidant response element (ARE) linked gene expression and explain that it is a novel strategy to suppress endothelial cell dysfunction and possibly also the development of vascular extremities, leading to possible amputation.

Farahmandi *et al.*, 2013 conducted one study aimed at assessing the effect of Broccoli leaves extract on the blood glucose and lipid profile in diabetic rats. Thirty male adult rats were randomly selected and divided into three groups as nondiabetic control; diabetic control; diabetic rats treated with hydroalcoholic extract of broccoli leaves. In diabetic groups alloxan monohydrate (100 mg/kg) was injected intraperitoneally to develop diabetes. Then the est group received intraperitoneal injection of hydro-alcoholic extract of broccoli leaves (100 mg/kg). At last, glucose cholesterol, triglyceride, HDL, VLDL, LDL and insulin contents of the rats' serum sample were determined Diabetic rats treated with extract showed a significant decrease in blood glucose level ($p<0.05$). Furthermore compared diabetic group, in the extract-treated rats, there was a significant decrease in serum contents of total cholesterol (TC), LDL, VLDL and TG, but a significant increase in insulin level and HDL ($p<0.05$). These results show that the hydroalcoholic extract of broccoli leaves may be effective in the treatment of diabetes. This effect can be due to the presence of flavonoides and their antioxidant features. Sulforaphane works by activating genes that regulate antioxidant and detoxifying enzymes. The effects of Sulforaphane on blood vessel cells damaged by high glucose levels (hyperglycaemia). It has observed a significant reduction of molecules in the body called Reactive Oxygen Species (ROS). Hyperglycaemia can cause levels of ROS to increase three-fold and such high levels can damage human cells. The results of the study showed that Sulforaphane reversed this increase in ROS by 73 per cent (http://www.physorg.com/news137255750.html). It is present in broccoli to the level of 12 jig/lOOgm (Kovács *et al.,* 2007). It is recently projected that chromium picolinate improves glycemic control in overweight to obese individuals with type 2 diabetes as an adjuvant to current antidiabetic medications (Ibarracin *et al.,* 2008).

Role of Broccoli leaf and floret in lowering lipid profile:

Cardiovascular diseases account for approximately 20% of all annual worldwide deaths, and remain the leading cause of death in both developed and developing countries (Wattanapitayakul *et al.,* 2001). Several studies have shown that oxidative stress plays a critical role in the different forms of cardiovascular disorders, including congestive heart failure, atherosclerosis, myocardial ischemia, and chemical-induced cardiac toxicity (Molavi *et al.,* 2004). A study on the intake of broccoli sprouts high in glucoraphanin, whose metabolite sulforaphane is a potent phase II protein inducer, decreased oxidative stress and inflammation in kidneys and the cardiovascular system explaining the reduction of the risk of developing cardiovascular problems of hypertension and atherosclerosis in spontaneously hypertensive stroke prone rats (Lingyun *et al.,* 2004). The promotion of cardiovascular function was similar to that seen with long-term consumption of pharmacological antioxidants. Murshima et al 2004 conducted a recent clinical study with 12 healthy subjects has suggested that consumption of fresh broccoli sprouts (100 g/day) for one week impacted oxidativestress markers and cholesterol values. Cholesterol levels, plasma amino acids, natural killer cell activity, serum coenzyme Q 10, and markers of oxidative stress — plasma phosphatidylcholine hydroperoxide (PCOOH), urinary 8-isoprostane, and urinary 8-hydroxydeoxyguanosine — were measured pre- and post treatment.

After only one week of broccoli sprout intake, all subjects demonstrated decreased serum totaland LDL cholesterol levels and reductions in all oxidative stress markers; females also had significantly increased HDL-cholesterol levels. Yochum *et al.*, 1999 done another related prospective study of 34,492 postmenopausal women in Iowa showed that broccoli was strongly associated with reduced risk of coronary heart disease. Broccoli treatment can improve cardiac function, reduce myocardial infaraction and cardiomyocyte appoptosis after ischemic reperfusion injury. Taken together, broccoli can protect mammalian heart from ischemic reperfusion injury by boosting thioredoxin level. Broccoli consumption can prevent the reduction of mRNA level and protein level of thioredoxin super family members due to ischemic reperfusion injury (Mukherjee *et al.*, 2008). Ischemia/reperfusion causes cardiomyocyte death by activating death signaling pathway and/or inhibiting survival signaling pathway (Das *et al.*, 2008). But broccoli treatment can induce the components of survival pathway (Mukherjee *et al.,* 2008). This probably is due to the presence of sulforaphane present in broccoli which can induce Trx, a cardioprotective protein through the antioxidant-responsive element (Tanito *et al.*, 2005).

The cardioprotective effects of broccoli probably involves multiple interlinked mechanisms, such as: (a) inhibition of phase I enzymes and DNA adducts; (b) induction of phase II antioxidant detoxifying enzyme; (c) antioxidant function; (d) induction of cell cycle arrest; (e) inhibition of angiogenesis; and (f) anti-inflammatory properties. In order to study the bioactive compound mediating cardioprotection in broccoli two active principles namely sulphoraphane and oltipraz treated rats are being subjected to ischemic reperfusion injury and the study is underway. However, structure activity relationship studies in this line are warranted (Hannah *et al.*, 2009). Yoon et al. 2008 conducted one animal studies on ischemia-reperfusion injury in the kidneys of Sprague-Dawley rats was obliterated by 0.5 mg SF/kg BW i.v. given 24 h before the injury, leaving serum creatinine and kidney weight no longer different from control. A second study evaluated the effect of dietary broccoli (a slurry containing *0.5 lmol SF/kg rat/day for 30 days) on prevention of ischemia reperfusion injury to the heart, and found decreased MI size and decreased apoptosis of cardiomyocytes, suggesting cardioprotection (Mukherjee et al. 2008). Similarly, stroke-prone SHRsp rats were fed a diet containing broccoli sprouts (200 mg/d) from the age of 5 weeks, and were seen to benefit from the diet (Wu *et al.*, 2004). By 19 weeks they had significantly higher tissue GSH levels (aorta, heart, kidney) and lower blood pressure than their A1N93 control-fed counterparts, which spontaneously developed oxidative stress, loss of tissue GSH and elevated blood pressure.

Other effect of broccoli on diseases:

Several epidemiological studies have shown that consumption of large quantities of fruits and vegetables, especially cruciferous vegetables (e.g. Broccoli and Brussels sprouts), can protect against carcinogenesis, mutagenesis, drug toxicities, and other chronic diseases (Conaway *et al.*, 2002; Shapiro *et al.*, 2001). Cruciferous vegetables are a rich source of glucosinolates, which, upon chewing, are enzymatically hydrolyzed by the plantspecific myrosinase (-thioglucoside N-hydroxysulfates; EC 3.2.3.1) and release isothiocyanates (Fahey *et al.*, 1997, 2001; Shapiro *et al.*, 2001).

Cancer:

The consumption of cruciferous vegetables has been associated to the prevention of lung, pancreas, bladder, prostate, thyroid, skin, stomach and colon cancer. A study suggested that intake of cruciferous vegetables have an inverse effect on bladder cancer. Like other cruciferous vegetables, broccoli also has anticancer properties due to the presence of constituents like sulforaphane, indoles, polyphenols, vitamins and minerals. Understanding the mechanisms of the chemoprotective effects of isothiocyanates is of great importance because isothiocyanates and their glucosinolate precursors are widespread in plants consumed by humans. Research on anticarcinogen functional foods has focused on broccoli and its bioactive constituents. A review by Verhoeven and coworkers 1997 on brassica consumption and cancer risk found that 67% of all studies reported an inverse association between consumption of total Brassica vegetable intake and risk of cancer at various sites; cohort studies found the greatest inverse associations between the consumption of broccoli and risk of several cancers including lung and stomach cancer. Sulforaphane has been found to have protective effects against carcinogen-induced tumorogenesis in rodents.

Myzak *et al.*, 2007 revealed in a pilot study involving three healthy volunteers (ages 18-55), a single daily dose of 68 g BroccoSprouts® (approximately 105 mg sulforaphane) significantly inhibited HDAC activity in peripheral blood mononuclear cell cultures three and six hours following consumption, suggesting sulforaphane may induce cell cycle arrest and apoptosis in humans. Kensler *et al.*, 2005 conducted one study in which the first direct observation of sulforaphane's inhibitory effect on cancer in humans was observed in 200 healthy adults (ages 25-65) from the Jiangsu Province of China, a region with a high rate of hepatocellular carcinoma due to excessive dietary aflatoxin exposure and chronic hepatitis B infection. The primary end-point of this blinded, placebocontrolled trial was to determine if drinking daily broccoli sprout infusions (containing 400 µmol glucoraphanin) for two weeks could reduce urinary excretion of aflatoxin DNA adducts - indicators of DNA damage. A highly significant inverse association was observed for excretion of dithiocarbamates (isothiocyanate metabolites of glucoraphanin) and aflatoxin-DNA adducts in individuals treated with broccoli sprout infusions. An average of approximately 12 percent (range 1-45 %) of the administered dose of broccoli sprout glucoraphanin was excreted as dithiocarbamates, with significant variability in excretion rates. The reason for this variation may be due to differences in enteric microflora composition, some individuals possibly having less myrosinase. Genetic polymorphisms of the glutathione S-transferase enzyme involved in glucoraphanin metabolism may also be partially responsible.

Helicobacter Pylori:

Gastric infection with Helicobacter pylon is a cosmopolitan problem, and is especially common in developing regions where there is also a high prevalence of gastric cancer. These infections are known to cause gastritis and peptic ulcers, and dramatically enhance the risk of gastric cancer. Eradication of this organism is an important medical goal that is complicated by the development of resistance to conventional antimicrobial agents and by the persistence of a low level reservoir of H. pylon within gastric epithelial cells. Sulforaphane [([1)- 1 -isothiocyanato-(4R)-(methylsulfinyl) butane], an isothiocyanate abundant as its glucosinolate precursor in certain varieties of broccoli and broccoli sprouts, is a potent bacteriostatic agent against 3 reference strains and 45 clinical isolates of H pylon [minimal inhibitory concentration (MIC) for 90% of the strains is [14 Dglml], irrespective of their resistance to conventional antibiotics. Further, brief exposure to sulforaphane was bactericidal, and eliminated intracellular H. pylon from a human epithelial cell line (Hep-2) (Basten *et al.*, 2002) Daily intake of SF-rich broccoli sprouts for 2 months reduces Helicobacter pylon (Helicobacter pylori) colonization in mice and improves the consequence of infection in infected mice and in humans (Yanaka *et al.*, 2009). This therapeutic effect was not observed in mice in which the Nrf2 gene was deleted, strongly indicating the important role of Nrf2-dependent antioxidant effect (Yanaka *et al.*, 2009). Several recent human studies have also reported the potential effect of SF for the eradication of H.pylori infection (Galan *et al.*, 2004; Fahey *et al.*, 2002).

Isothiocyanates and the glucosinolate I myrosinase system that leads to their production in cruciferous vegetables like broccoli plays a major role in plant defense against fungal diseases and pest infestation(Eas *et al.*, 1997). Animal research shows sulforaphane given to human gastric xenograft bearing mice at a daily dose of 1.33 mg (equivalent to a 100-mg daily dose in humans) is strongly bacteriocidal and eradicates H pylori.(Haristoy *et al.*, 2003).

Conclusion:

Use of medicinal plants in medicine is increasing because of their widespread use and for their curing various diseases. Broccoli constituents mediate a variety of physiological functions by acting as antioxidants, regulating enzymes, and controlling apoptosis and cell cycle. This emphasizes the consumption of this vegetable associated to the prevention of disease condition such as cancer, cardiovascular disorders, ulcers and diabetes. The organosulfur phytochemicals namely glucosinolates and the S-methyl cysteine sulphoxide found in broccoli in concert with other constituents such as vitamin E, C, and K, and minerals such as iron, zinc, and selenium, and the polyphenols namely kaempferol, quercetin, glycosides and isorhamnetin are presumably responsible for the various health benefits of broccoli. Hence, broccoli can be considered as a potential functional food. Further work is needed to better define the molecular mechanism by which the constituents of broccoli can act at the cellular level, modifying various disease conditions and translating the information to human beings. Sulforaphane and glucoraphanin from broccoli, broccoli sprouts, and broccoli seeds has a good safety profile with no known contraindications or drug interactions. It is broadly accepted that dietary broccoli can protect against a number of different cancers and possibly several other chronic diseases. Yet most data supporting these statements focus on purified or semipurified SF, or a water extract of broccoli sprouts, rather than whole broccoli. There are a significant number of epidemiological studies identifying a role for cruciferous vegetables in protection against cancer and other chronic diseases.

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