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Pharma Research Library  
**International Journal of Current Trends in Pharmaceutical Research**  
2013, Vol.1 (2): 81-87

ISSN 2321-3760



Review Article



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**Phytochemical Potentiality of Broccoli, Tomato and Garlic**

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**Abstract**

With the growing industrialization, various types of carcinogens are spreading in our environment that poses the risk of different hues of cancer. A food rich in antioxidants, polyphenols and other phytochemicals help in combating with the threat to cause some forms of cancer. The first question that comes to or mind is how foods exactly fight against cancer. Certain phytochemicals present in the food prevent the formation of carcinogens and keep carcinogens away from reaching important sites in the body. Other phytochemicals keep cells that have been exposed to carcinogens from becoming malignant. Phytochemicals also strengthen the body's immune system and function as antioxidants to flush out free radicals. In this manuscript, phytochemical strength of broccoli, tomato and garlic is described preciously.

**Key words:** Antioxidants; Lycopene, Allinase, Glucoraphanin, Organic Acids, Amino acids, CHD, Cancer

**Introduction**

**Historical Background and Nutritive Value of Broccoli**

Among different foods, Italian broccoli, which is simply called as broccoli, a vegetable belonging to the Brassicacea family has proven to be the most potent one. The word 'broccoli' has been derived from the Italian plural of broccoli, which refers to 'the flowering top of a cabbage'. Broccoli was evolved from a wild cabbage i.e. *B.*

*Oleracea* on the continent of Europe (Giri and Singh, 2012). Some other cultivar groups of *Brassica oleracea* are cabbage, kale, kohlrabi, Chinese broccoli, cauliflower and Brussels sprouts. Broccoli is native to the Mediterranean region and it has been known for over 2000 years ago. It was a favourite food of the ancient Romans and was first introduced to France in the 1500s and to England in 1720. Since the Roman Empire, it has been considered a uniquely valuable food among Italians and firstly introduced to the United States by Italian immigrants but didn't become widely known until the 1920s. There are three commonly grown types of broccoli. The common broccoli (Botrytis group) was developed to have a dense, central flowering head as calabrese named after Calabria in Italy. It's a cool season annual crop. Sprouting broccoli also known as Italian broccoli and asparagus broccoli. Asparagus broccoli has a large number of heads with many thin stalks. Romanesco broccoli has a distinctive fractal appearance of its heads, and is yellow-green in colour. It is technically report from UOI proved that the cancer fighting power of broccoli has been maximized when it has been heated for 10 minutes at 140 degrees Fahrenheit.



It has also been showed that boiling reduces the levels of suspected anti-cancer compounds in broccoli, with losses 20-30% after five minutes, 40-50% after ten minutes, and 77% after thirty minutes. Broccoli contains a number of compounds with potent anti-cancerous properties, including diindolylmethane and small amount of selenium (Se). Particularly 3, 3'-Diiindolylmethane is an active modulator of the innate immune response system with anti-viral, anti-bacterial and anti-cancerous activities. Similarly, like other brassica vegetables, broccoli is also rich in glucosinolates, which are metabolized to cancer preventive substances like isothio-cynates. Researchers of the LCCC at the UOG studied that gene P53., which helps fight cancer when normal, become mutated, eliminating its ability to fight cancer. Vegetables such as broccoli contain compounds known as isothiocynates, which selectively bind to the mutated genes, depleting them, and helping cause cancer cell death.

The study suggest that depletion of the mutated P53 gene may be an important target for chemo-prevention and therapy treatments, by making use of synthetic and naturally occurring isothiocynates. Glucoraphanin, a compound present in broccoli can be processed into an anti-cancer compound sulforaphane which has been studied previously for its effects on cancer, but study at UOI showed that it is beneficial in inhibiting the breast cancer by targeting the cancer cells. This new insight suggests the potential of sulphoraphane from the broccoli extract. Researchers then used several established methods to assess the number of cancer stem cells in the tumors.

**Table 1: Nutritional Constituents of Broccoli (per 100g of raw edible part)Energy=30kcal**

Constituent	Quantity	Constituent	Quantity
Carbohydrate	6.64g	Niacin (vit B3)	0.639mg
Sugar	1.7g	Pantothenic acid (vit B5)	0.573mg
Dietary fibre	2.6g	Vitamin B6	0.175mg
Fat	0.37g	Folate (vit B 9)	63mg
Protein	2.82g	Vitamin C	89.2mg
Water	89.30g	Calcium	87mg
Vitamin A	31ig	Iron	0.73mg
B-carotene	361ig	Magnesium	21mg
Thiamine (vit B1)	0.071mg	Phosphorus	66mg
Riboflavin (vit B2)	0.117mg	Potassium	316mg
		Zn	0.41mg

Source: USDA Nutrient database

These measures showed a marked decrease in the stem cell population after treatment with sulphoraphane, with little effect on the normal cells. Further, cancer cells from mice treated with sulphoraphane were unable to generate new tumors. The researchers then tested sulphoraphane on human breast cancer cell cultures in the lab and found similar decreases in the cancer stem cells. Besides the anti-cancerous properties of broccoli it's also a rich source of vitamin C, indole-3-carbinol, carotenoids, lutein and dietary fibre (Table 1). According to USNCI eating broccoli once in a week decreases the aggressive prostate cancer by 45% to 52%. Broccoli grows best on well-drained soils that have good water-holding characteristics and must have a pH of 5.8 to 6.6.

### Historical Background of Tomato

The tomato is herbaceous, usually sprawling plant in the Solanaceae or nightshade family, as are its close cousins potatoes, chili peppers, tobacco, eggplant and the poisonous belladonna. It is a perennial, often grown outdoors in temperate climates as an annual. Typically reaching to 1-3 metres (3-10 ft) in height, it has a weak, woody stem that often vines over other plants. The leaves are 10-25 centimetres (4-10 in) long, odd pinnate, with 5-9 leaflets on petioles, each leaflet up to 8 centimetres (3 in) long, with a serrated margin; both the stem and leaves are densely glandular-hairy. The flowers are 1-2 centimetres (0.4-0.8 in) across, yellow, with five pointed lobes on the corolla; they are borne in a cyme of 3-12 together.

The tomato is native to South America. Genetic evidence shows that the progenitors of tomatoes were herbaceous green plants with small green fruit with a center of diversity in the highlands of Peru. These early *Solanum* diversified into the dozen or so species of tomato recognized today. One species, *Solanum lycopersicum*, was transported to Mexico where it was grown and consumed by prehistoric humans. The exact date of domestication is not known. Evidence supports the theory the first domesticated tomato was a little yellow fruit, ancestor of *L. cerasiforme*, grown by the Aztecs of Central Mexico who called it "xitomatl", meaning plump thing with a navel, and later called *tomatl* by other Mesoamerican peoples. Aztec writings mention tomatoes were prepared with peppers, corn and salt, likely to be the original salsa recipe.

Some people believe that the Spanish explorer Cortez may have been the first to transfer the small yellow tomato to Europe after he captured the Aztec city of Tenochtitlan, now Mexico City in 1521. Yet others believe Christopher Columbus, an Italian working for the Spanish monarchy, discovered the tomato earlier in 1493. The earliest discussion of the tomato in European literature appeared in an herbal written in 1544 by Pietro Andrea Mattioli, an Italian physician and botanist, who named it *pomi d'oro*, golden apple.

The word tomato comes from a word in the Nahuatl language, *tomatl*. The specific name, *lycopersicum*, means "wolf-peach" (compare the related species *Solanum lycocarpum*, whose scientific name means "wolf-fruit", common name "wolf-apple"), as they are a major food of wild canids in South America. French botanist Tournefort provided the Latin botanical name, *Lycopersicon esculentum*, to the tomato. It translates to "wolfpeach" peach because it was round and luscious and wolf because it was erroneously considered poisonous. The botanist mistakenly took the tomato for the wolfpeach referred to by Galen in his third century writings, i.e., poison in a palatable package which was used to destroy wolves.

The English word *tomato* comes from the Spanish word, *tomate*, derived Nahuatl (Aztec language) word, *tomatl*. It first appeared in print in 1595. A member of the deadly nightshade family, tomatoes were erroneously thought to be poisonous (although the leaves are poisonous) by Europeans who were suspicious of their bright, shiny fruit. Native versions were small, like cherry tomatoes, and most likely yellow rather than red. The tomato is native to western South America and Central America. In 1519, Cortez discovered tomatoes growing in Montezuma's gardens and brought seeds back to Europe where they were planted as ornamental curiosities, but not eaten. Most likely the first variety to reach Europe was yellow in color, since in Spain and Italy they were known as *pomi d'oro*, meaning yellow apples.



Italy was the first to embrace and cultivate the tomato outside South America. The French referred to the tomato as *pommes d'amour*, or love apples, as they thought them to have stimulating aphrodisiacal properties.

In 1897, soup mogul Joseph Campbell came out with condensed tomato soup, a move that set the company on the road to wealth as well as further endearing the tomato to the general public. Campbell may have made tomato soup popular, but the first recipe is credited to Maria Parloa whose 1872 book *The Appledore Cook Book* describes her tomato chowder. The high acidic content of the tomato makes it a prime candidate for canning, which is one of the main reasons the tomato was canned more than any other fruit or vegetable by the end of the nineteenth century.

### Nutritive Value of Tomato

*Nature's gift to humans, tomatoes not only taste good but are also packed with many essential vitamins and minerals that promote health and well being.* No doubt, because of very special value, tomato is the world's largest vegetable crop. Fresh ripe tomatoes are popularly consumed raw in salad as well as curried in combination with a variety of vegetables. Soups, Juice, pastes, sauces, ketchups, purees are value added products of processed and canned tomatoes. Tomato has an excellent nutritional profile owing largely to its balanced mixture of minerals (K, Ca, P, Fe and Zn) vitamins (A, B1, B2, B6, biotin, folic acid, nicotinic acid, pantothenic acid, C, E and K), and antioxidants such as carotenoids and polyphenolic compounds (Sharma et al., 2009).

**Composition of fully ripe tomato (weighing 150gm)**-Carbohydrates, Proteins, Fat, Na, K, Ca, Mg, P, Cl, Fe, Vitamin A, E, Thiamine, Niacin, Ascorbic acid, Fibre; Quantity 4.1g, 1.6g, 0.5g, 50.0mg, 114.0mg, 27.0mg, 18.0mg, 23.0mg, 40.0mg, 1.9mg, 1680 IU, 0.9mg, 0.12mg, 0.09mg, 1.8mg, 46.0mg, 40.0mg, 46.0mg, 0.8g respectively. Among minerals Al, Mn, Co, B, As and I are also found in traces. Many organic acids viz. citric, malic, acetic, lactic, succinic, caffeic, hydroxyl cinnamic and oxalic acids are also present in tomatoes. Out of 20 amino acids, 18 are present in tomato including isoleucine, leucine, lysine, methionine, cysteine, phenyl alanine, tryptophan, threonine, valine, arginine, histidine, alanine, aspartic and glutamic acids, glycine, proline and serine. Health benefits of tomatoes are attributed to a balance content of minerals, vitamins and phytonutrients viz. carotenoids, polyphenolic compounds, etc. According to NCI, people who consume large amounts of tomatoes and tomato products have a significantly low risk of prostate, lung and stomach cancer. There is some evidence that people consuming a lot of tomatoes may also have a lower risk of pancreatic, colorectal, oesophageal, oral, breast and cervical cancers. How do tomatoes help fighting cancers? The consensus seems to be that lycopenes, bioflavonoids (closely related to  $\beta$ -carotene), are the natural cancer fighting agents present in tomatoes. Cooking releases the fat-soluble lycopenes from the fruit cells and increases the effectiveness of lycopene.

A small amount of added oil, such as that in pizza or tomato sauce, intensifies the protective effect. Studies have shown that lycopene reduces the risk of CVD. The tomato helps to dissolve animal fat in foods such as butter, cheese and many deep-fried foodstuffs, thereby preventing hardening of the arteries. Tomato is also useful in reducing HBP, a major threat factor for CHD and stroke. Recent research has demonstrated that lycopene present in red tomato is at least twice effective as  $\beta$ -carotene in protecting blood lymphocytes from  $\text{NO}_2$  radical damage. LDL oxidation gets prevented efficiently by a combination of lycopene and vitamin E than each substance separately. A clinical study showed that Lithuanians who suffered a high rate of mortality from CHD have low lycopene levels. Tomato extract branded as Lycomoto now is also being promoted for treatment of HBP. Since tomatoes are rich of K (114.0g), clinical studies have indicated that they have a positive effect on the kidneys in many cases and good renal functioning can reduce HBP. In 1946, Dr Lester M Morrison of The PGH described that tomato pomace relieved in diarrhoea due to food poisoning, mucous and septic colitis, nutritional deficiencies and food allergy in > 100 cases as reported in *American Journal of Digestive Diseases*. It's believed that eating one or two fresh tomatoes relieve bloodshot eyes by strengthening the blood vessels. Hypoglycaemic people (those who have low blood sugar) are beset with constant fatigue and lack of energy. Tomatoes are successfully used in rebuilding their strength.



1. Tomatoes contain several naturally occurring sugars accounting for nearly 50% of the total dry matter. Ripe tomatoes are especially high in glucose and fructose.
2. Tomatoes stimulate liver mechanism. Doctors at TU in Sendai, Japan have reported that fresh tomato juice is extremely effective in accelerating the glycogen (blood sugar) formation in rabbits.
3. Tomato seeds are a great source of protein, which is similar to that of sunflower and soybean protein.
4. Tomatoes play important role in liver health too. Russian doctors prescribe tomatoes in the diet of factory workers exposed to toxic chemicals. Because of the presence of chlorine (51mg/100g) and S (11mg/100g)-uncooked tomato, the two very important detoxifying trace elements, the effect gets rectified. S helps to protect liver from cirrhosis and other debilitating conditions. According to John Heinerman– a noted author and Herbalist – A tomato a day, keeps the liver a good stay!

**Raw tomato may not be as healthy as we think:** Tomatoes eaten raw mightn't be so healthy, depicts a new study, because our digestive tract can only process a tiny amount of lycopene, an antioxidant which prevent damage to body cells or reverse damage. In the study, it was traced that although ~ 75% of the total antioxidants were released, this induced only 4% of the lycopene found in the raw tomatoes available for the body to use. Processing tomatoes has been shown to make lycopene more bio-available, so we should consume tomato sauces to get the goodness of lycopene.

**Tomatoes in sun (Fresh isn't always the best):** There are flavours that seduce us with subtlety, like the lingering richness of sun dried tomato. Bite into a piece of sun-dried tomato, in a salad, baked into bread, on a slice or pizza and our taste buds are overwhelmed by an intense salty-sweet-sourness that, as we chew, releases a rich mellowness that accentuates and amplifies those original flavours. It's a taste of sunlight in which the tomato grew, in which the sugars that make some people consider it a fruit ripened, and the acidity that makes others consider it a vegetable also developed. Dried fruits and veggies are often disappointing, with desiccated mouth feel. But the acid sweetness of tomatoes overrules that, and adds a chemical twist. One of the reason that we like we like tomatoes so much is because they usually high levels of glutamic acid (- the substance that in pure chemical form is monosodium glutamate which marketed as *ajinomoto* and infamously overused by Chinese restaurants) . The fabulous taste of sundried tomatoes is via concentrated glutamic acid. Yet they are hard to get in India, and don't see why: we have tomatoes, we have sunlight, we have long tradition of drying veggies, so why are sundried tomatoes so expensive and hard to find outside gourmet stores? Sun dried tomatoes are really a different product, preserving full flavour at their best, rather than the anaemic out of season ones we get these days. Recently in Italy San Marzanos, tomatoes grown in the volcanic soil of Mt Vesuvius, yet sweet, salty yet fruity and full of flavour. Putting tomatoes in olive oil with some garlic cloves help extending flavour (Sharma et al., 2009).

### Historical Background of Garlic

The word *garlic* comes from Old English *garleac*, meaning "*spear leek*." Dating back over 6,000 years, it is native to Central Asia, and has long been a staple in the Mediterranean region, as well as a frequent seasoning in Asia, Africa, and Europe. Egyptians worshiped garlic and placed clay models of garlic bulbs in the tomb of Tutankhamen. Garlic was so highly-prized, it was even used as currency. Folklore holds that garlic repelled vampires, protected against the Evil Eye, and warded off jealous nymphs said to terrorize pregnant women and engaged maidens. And let us not forget to mention the alleged aphrodisiacal powers of garlic which have been extolled through the ages. Surprisingly, garlic was frowned upon by foodie snobs in the United States until the first quarter of the twentieth century, being found almost exclusively in ethnic dishes in working-class neighbourhoods. But, by 1940, America had embraced garlic, finally recognizing its value as not only a minor seasoning, but as a major ingredient in recipes. Quaint diner slang of the 1920's referred to garlic as *Bronx vanilla*, *halitosis*, and *Italian perfume*. Today, Americans alone consume more than 250 million pounds of garlic annually (DTE, 2009<sup>a</sup>).



### Nutritive Value of Garlic

From curing ulcer, garlic finds many uses. Allicin – the organic compound that imparts garlic its aroma, flavour and properties – is the world's most powerful antioxidant. Recently it has been shown how allicin functions as a radical scavenger – a previously known phenomenon. Experiments carried out with synthetically-produced allicin found that it decomposes into sulphenic acid which is extremely reactive towards free radicals, making allicin a potent antioxidant (DTE<sup>b</sup>, 2009). Usually antioxidant found in flavonoids found in green tea and grapes, are present in substantially high quantities which make them highly effective. The study, published in January 2009 issue of the German journal *Angewandte Chemie*, explains why allicin is such powerful antioxidant even though it's present in relatively smaller quantities in the plant. Garlic has long been considered a medicinal food. It was used to protect against plague by monks in the middle ages. Hippocrates used garlic vapors to treat cervical cancer. Garlic poultices were placed on wounds during World War II as an inexpensive and apparently quite effective replacement for antibiotics which were scarce during wartime. Now science is beginning to prove the medicinal properties of garlic that our ancestors took for granted. Studies have shown garlic can suppress the growth of tumors, and is a potent antioxidant good for cardiovascular health. Other studies show garlic can reduce LDLs or "bad" cholesterol and is a good blood-thinning agent to avoid blood clots which could potentially lead to heart attack or stroke.

### Why does garlic smell and what causes it?

Answer: When garlic cells are ruptured by cutting or pressing, they release an enzyme called *allinase*. This enzyme chemically changes the inherent *alliin* into *allicin*, a sulfur-containing molecule, resulting in that heady, pungent garlic smell which is a mainstay in kitchens around the world. These sulphur molecules are absorbed into the bloodstream and lungs, escaping through exhaled air and perspiration. Thus, the garlic breath. And, in some people who consume massive quantities, a noticeable garlicky bodily odor can result. If you are a garlic-lover, it's wise to surround yourself with others who enjoy garlic, or try munching on parsley to rid yourself of garlic breath. It's much easier to get the smell of garlic off your hands than it is to get rid of garlic breath. To rid your hands of the smell after peeling and/or chopping garlic, simply wash your hands and then rub your clean hands on a chrome faucet. It works like magic (DTE, 2009<sup>b</sup>)!



**Processed garlic loses its ability to protect the heart:** Freshly cultivated garlic release  $H_2S$  due to which it smells like rotten eggs (DTE<sup>b</sup>, 2009). This discourages many from consuming the cloves fresh. Keeping in mind its health benefits, the food processing industry produces edible garlic pills and powder which don't possess the smell. In accordance with the new findings, the pills are less effective or don't do any good, especially in protecting cardiac ailments. Researchers from the UCSM, USA, provide the first scientific evidence that freshly crushed garlic is healthier for heart than dried or processed one. The study published in *Journal of Agricultural and Food Chemistry* notes that garlic's benefits are due to the  $H_2S$  and not antioxidant, as believed earlier. Experiments were carried out in the two groups of rats: one received freshly crushed garlic while the other was given dried garlic for 30 days. One set of rat was kept on placebo. After doing so, stimulation of heart attack was performed in all the three groups. Both crushed and processed garlic fed rats were found with reduced damage from lack of oxygen, but the group that received fresh garlic indicated significantly greater restoration of normal blood flow. Raw, crushed garlic produces  $H_2S$ <sup>5</sup>.

### Conclusion

Conclusively, it can be front forwarded that phytochemicals extracted from natural products help scavenging free radicals which cause various ailments in human beings. So one should rely in consuming veggies and fruits specially coloured ones at the time of dinner or lunch to remain healthy.

### Abbreviations

NCL; National Cancer Institute; CVD: Cardiovascular Disease; HBP: High Blood Pressure; CHD: Coronary Heart Disease; LDL: Low Density Lipoprotein; PGH: Philadelphia General Hospital; TU: Tohoku University; H<sub>2</sub>S: Hydrogen Sulphide; UCSM: University of Connecticut of Medicine; UOI: University of Illinois; LCCC: Lombardi Comprehensive Cancer Center; UOG: University of Georgetown; USNCI; USDA (United States Dietary Association); United States National Cancer Institute; NO<sub>2</sub>: Nitrogen per oxide; K: Potassium; S: Sulphur

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