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... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

Vitamin C : an amazing chemical

Vitamin C is an essential vitamin for human health. Chemically it is L-ascorbic acid. Vitamin C is an excellent antioxidant. It has a very interesting and inspiring history. Ascorbic acid derives its name from the Latin word *scorbutus*, which is the Latin name for the disease called scurvy. As scurvy can be treated with this vitamin, the letter 'a' (meaning no) was prefixed to mean that it is caused by a deficiency of the vitamin. In olden times sailors, especially those who used to set out for long voyages, used to suffer extensively from scurvy, the chief reason for this disease is incomplete synthesis of collagen, a fibrous protein, in the body. As a result the body parts start getting slackened because it is collagen that binds them like cement and provides structural support to them. Vitamin C deficiency weakens the cartilage present in the joints. The main symptoms of scurvy are internal bleeding, muscle weakness, bleeding and painful gums, loosening of teeth, pain and inflammation in joints, slow healing of wounds, etc. In 1497, when Vasco da Gama set out for his sea voyage from Portugal to India, the curative effects of citrus fruits were known at that time. The Portuguese, therefore, set up fruit and vegetable plantations at many places. In Saint Helena, a stopping point for homebound voyages, they used to leave the sick sailors, suffering from scurvy and other sea ailments, to recuperate by consuming citrus fruits. The sailors were subsequently taken home by the next ship.

According to an estimate, between 1500 AD and 1800 AD, scurvy killed at least two million sailors. Jonathan Lamb wrote: "In 1499, Vasco da Gama lost 116 of his crew of 170; in 1520, Magellan lost 208 out of 230... all mainly to scurvy. One can gauge from this how hazardous sea voyages used to be in the olden days. However, scurvy by any count is not a new disease. It has also been mentioned by Hippocrates (460 BC-380 BC) who is regarded as the father of Western medicine. According to some references, the



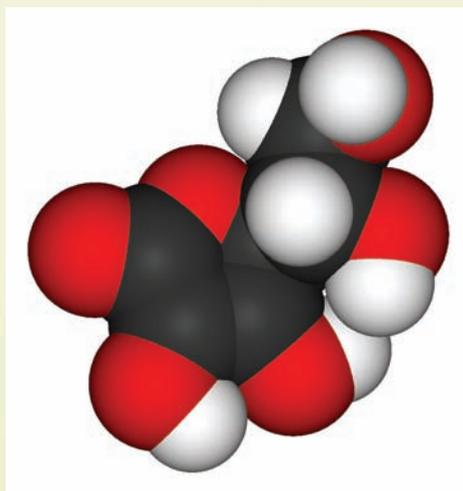
Albert Szent-Györgyi

use of herbs to treat scurvy was made by some local communities of prehistoric age.

The credit for discovering vitamin C goes to the Hungarian scientist Albert Szent-Györgyi (16 September 1893-22 October 1986). He was awarded the Nobel Prize in Physiology or Medicine in 1937 for his discoveries in connection with the citric acid cycle, that is,

biological combustion process with special reference to vitamin C and the catalysis of fumaric acid. The importance of vitamin C can be gauged from the fact that in the same year (1937), Walter Norman Haworth was also awarded the Nobel Prize in Chemistry for unveiling its chemical structure. It sounds quite incredible that two Nobel Prizes were awarded in the same year for work on a chemical compound.

Vitamin C is a water-soluble white crystalline substance, which is sour in taste. Earlier, ascorbic acid was known by the name of hexuronic acid, Due to its high solubility in water, vitamin C is easily absorbed by the small intestine. It directly reaches the liver



Vitamin C molecule



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from blood and from the liver it then reaches different parts of the body. If taken in excess, it easily excreted from the body through urine.

Of all vitamins, vitamin C is the most unstable vitamin. When taken with other nutrients such as vitamin A and iron, it boosts the immune system of the body and keeps it healthy. The melting point of vitamin C is 190°C.

Main sources of vitamin C

Humans get vitamin C only through food products because the human body

is not able to synthesise it. As vitamin C gets easily oxidised, storing it in aerobic condition and cutting and cooking of vegetables containing it lead to its oxidation. On average, an adult requires 60 mg of vitamin C per day. Pregnant and lactating mothers need an additional of 10-30 mg per day. The main sources of vitamin C are sour and juicy fruits and all kinds of citrus fruits, such as, gooseberry,

orange, lemon, grapes, tomatoes, pineapple, strawberry, etc. Cantaloupe, kiwi, mango, guava, water melon, apple, bananas, berries, and green leafy vegetables, etc., are also good sources of this vitamin. In addition, spinach, fresh peas, wood apple jackfruit, turnip, mint radish leaves *munakka* (black raisins) milk, beetroot, amaranth, cabbage, green coriander, green and red chilli, broccoli, cauliflower, sweet and white potatoes and pumpkin one also considered to be good sources of vitamin C. Ascorbic acid is found in scant quantity in milk, eggs, mutton and chicken; sometimes it may not be present in these food items at all. The table below shows the amount of vitamin C present in different food items.

Free radical and reactive oxygen species

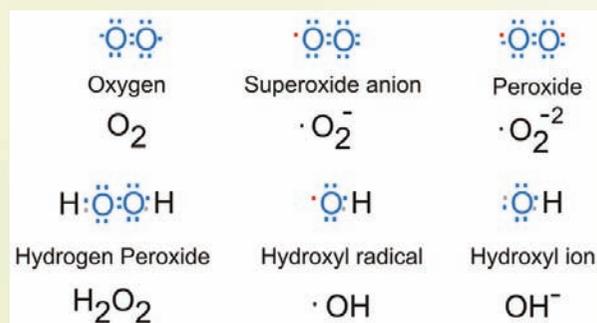
Free radicals are generated due to the oxidation of the body cells. Atoms or

Vitamin C: an amazing chemical

Table: The amount of vitamin C (ascorbic acid) in some food products

Food product	Ascorbic acid (mg/100 g)
Grapes	200
Cabbage	100
Cauliflower	70
Spinach	60
Orange	50
Lemon	50
Potatoes	30
Peas	25
Tomatoes	20
Lettuce	15
Carrot	6
Apple	5
Milk	2.1-2.7

groups of atoms having an odd (unpaired) number of electronic are called free radicals.



Free radical and reactive oxygen species

They have a deleterious effect on the body. Increased formation of free radicals in the body invites host of diseases. The process of the formation of free radicals increases with advancing age and due to free radicals wrinkles start appearing on the skin and there is a drop in the efficiency of the functioning of body parts.

Due to the presence of an odd or unpaired electron in free radicals, they have a strong affinity to get paired by attracting an electron. So they rapidly get paired by pulling an electron from neighbouring molecules. But, in this process the stable molecule from which one electron has been detached gets converted into a free radical. Now, this newly formed free radical pulls an electron from another stable molecule. In this way, a chain reaction for the formation of free radicals starts. These free radicals are highly reactive. If their formation rate becomes uncontrolled, cell death may occur.

Vitamin C has antioxidant properties which fights with the free radicals produced in the body and replenishes the supply of vitamin E in our body cells. Side by side, it also increases the capacity for iron absorption in the body. It also works as an anti allergic and antioxidant. Therefore, humans must take sufficient quantity of fruits and vegetables in their diet. Like free radicals there are some other kinds of molecules which have identical nature and are equally injurious to the body. Such molecules are dubbed as reactive oxygen species. Their formation takes place in the body due to a variety of reasons such as oxidation of food products, infection, mental stress, excessive exertion, and consumption of diet loaded with fats. Little or no consumption of fibrous fruits and vegetables also triggers their generation. Some environmental factors like pollution, ultraviolet and ionising radiation might also be the cause of their formation. Reactive oxygen species damage the nucleic acids

DNA and RNA by reacting with them and may give rise to such changes in the cells of the organisms as may lead to untimely ageing and the dreaded cancer in due course of time.. They also damage protein, lipids, etc. This raises the possibility of getting afflicted with the age-related diseases, such as cataract, diabetes, Parkinson's disease, Alzheimer's disease, gout, hypertension, insomnia, osteoporosis, cancer, depression, etc.

Vitamin C: An excellent antioxidant and free radical neutraliser

Antioxidants are those chemical compounds which prevent the oxidation of other substances. They get rid of the reactive oxygen species by reacting with them. By reacting with the free radicals found in the body due to oxidation, antioxidants neutralise them. Situated top on the list of antioxidants in vitamin C. Gooseberries are considered to be an excellent source of vitamin C. The vitamin C present in gooseberry is relatively stable and is not easily destroyed on heating. Extensive research has been carried out on properties of vitamin C. The most interesting property of vitamin C., as found by the researchers, is that it increases the antioxidant properties

of other vitamins manifold. By donating an electron to the free radicals, the activity of vitamin E gets neutralised and in the process, vitamin E itself gets converted into a free radical. In such a scenario, vitamin C, by constantly offering its electron to vitamin E, helps maintain the latter's reactivity. Vitamin C also has the property of replenishing the loss of its electron through recycling.

Vitamin C can offer improvement in the skin health and also some other benefits. Although, as found by researchers, daily consumption of 60 mg of vitamin C is good for health, its quantity in the blood of those who smoke is 25 percent less compared to the quantity in non-smokers. So, smokers, alcoholics and those having greater intake of caffeine need comparatively larger quantities of vitamin C. In addition, in cases of excessive mental tension, fever, infection, pregnancy and old age the requirement of vitamin C goes up proportionately.

Mood-setting role of Vitamin C

Vitamin C has a role in setting our mood. It helps formation of serotonin in the human brain. Serotonin, which is a neurotransmitter, regulates our mood. Chemically, it is 5-hydroxytryptamine (5-HT). It is biochemically derived from tryptophan. Good level of serotonin in the blood has the effect of increasing the level of happiness of a person. It also regulates sleep and appetite of a person. In persons suffering from worries and depression, the level of serotonin in blood is found to be low. To increase the level of serotonin, therefore, chemicals in the form of antidepressants are prescribed. Serotonin also has cognitive importance. It influences the memory and learning process. Therefore, a good level of serotonin increases the possibility of better learning and understanding by students. Vitamin C is also beneficial for our eyes. It protects us for glaucoma, which can make a person go blind.

Some biological roles of vitamin C

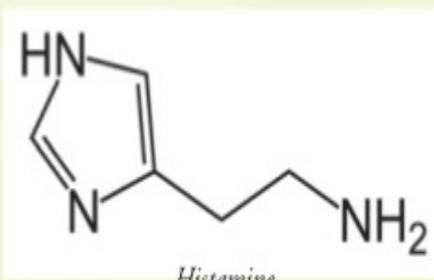
In the fundamental chemical reactions and in the formation of compounds in the body, vitamin C has a definite role. It helps in the metabolic processes of the cells. Vitamin C is helpful in carrying out various chemical reactions in the body, such as, communicating messages to the nerves ensuring energy flow

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to cells, etc. They help keep various parts of the body in proper shape. Besides, vitamin C is required for the formation of collagen that cements the bones, blood vessels, ligaments, cartilage, etc. It also regulates the amount of cholesterol in the body. It acts as a co-agent for hydroxyphenylpyruvate, an oxydising enzyme that breaks up tyrosine and thus catalyses the bio-synthesis of catecholamines. Vitamin C is also instrumental in the conversion of folic acid to the active formyl tetrahydrofolic acid.

The absorption of iron in the body is increased by vitamin C. It converts the ferric ion into ferrous ion which makes the absorption of iron by the intestine easier. Vitamin C helps in strengthening the blood vessels of the body. Lack of vitamin C may lead of bleeding gums and dental pain. There may be loosening of the gums leading to untimely loss of teeth. Therefore, one must regularly include vitamin C in



the diet. Those suffering from hypertension must take regular dose of vitamin C in their diet. It dilates the arteries and thus protects the person from the possible ill-effects of hypertension.

Due to its antihistaminic properties, vitamin C may act as a medicine to treat normal cough and cold. In biological system, superoxides or radicals produced as a result of chemical reactions damage the proteins or DNA of the body. By proper and regular intake of vitamin C, it may be possible to control the ageing process and the incidence of cancer. Vitamin C produces antibodies

and thus boosts the immune system of the body. Besides, vitamin C deficiency may increase the possibility of ulcer, scars on the face, weak lungs, cough and cold, and eye, nose and ear diseases, allergies, etc. Due to the lack of vitamin C, excessive bleeding may also take place on getting hurt because it plays an important role in the coagulation of blood.

It is thus amply clear that vitamin C is indeed an amazing chemical which has multifarious roles in keeping us healthy and disease-free.

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(Translation: Abhas Mukherjee)