Project Report on

Analysis of amount of vitamin C in different fruits"

Submitted By

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SIR P.T.SCIENCE COLLEGE, MODASA

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Certificate

This is to certify that project report entitled **"Analysis of Amount of Vitamin C in Different Fruits"** are carried out by students mentioned below. They have been satisfactorily completed their project work for academic year 2022-23. The project has been approved as it satisfies the academic requirement in respect of project work prescribed for the Master of Science. M.Sc-III

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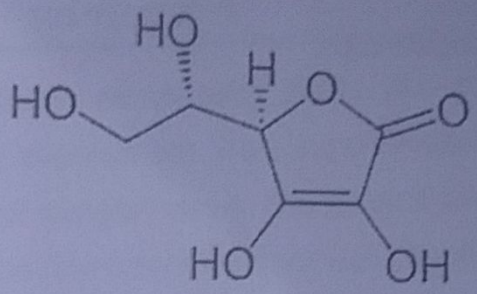
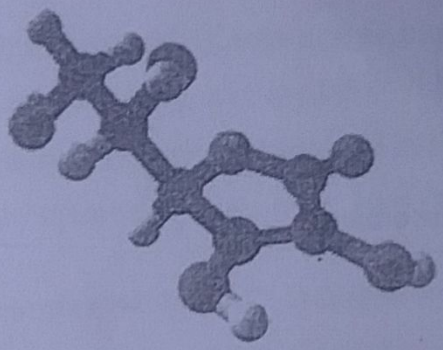
Vitamin C

pharmaceutical drug

For other uses, see Vitamin C (disambiguation).

Vitamin C





Clinical data

AHFS/Drugs.com	Monograph
MedlinePlus	a682583
Pregnancy category	A (to RDA), C (above RDA)
Routes of administration	by mouth, IM, IV, subQ
ATC code	A11G (WHO)

Legal status

Legal status	AU: Unscheduled
	US: OTC
	general public availability

Pharmacokinetic data

Bioavailability	rapid & complete
Protein binding	negligible
Biological half-life	varies according to plasma concentration
Excretion	kidney

Identifiers

IUPAC name

2-oxo-L-threo-hexono-1,4-lactone-2,3-enediol

or

(*R*)-3,4-dihydroxy-5-((*S*)- 1,2-dihydroxyethyl)furan-2(5*H*)-one

Synonyms	L-ascorbic acid, ascorbic acid, ascorbate
CAS Number	50-81-7
PubChem (CID)	5785
IUPHAR/BPS	4781
DrugBank	DB00126
ChemSpider	10189562
UNII	PQ6CK8PD0R
KEGG	D00018
ChEBI	CHEBI:29073
ChEMBL	CHEMBL196
NIAID ChemDB	002072
E number	E300 (antioxidants, ...)
ECHA InfoCard	100.000.061

Chemical and physical data

Formula

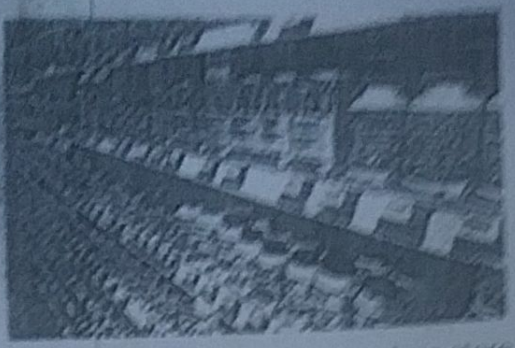
	$C_6H_8O_6$
Molar mass	176.12 g/mol
3D model (Jmol)	Interactive image
Density	1.694 g/cm^3
Melting point	190 °C (374 °F)
Boiling point	553 °C (1,027 °F)

Vitamin C, also known as **ascorbic acid** and **L-ascorbic acid**, is a vitamin found in food and used as a dietary supplement. As a supplement it is used to treat and prevent scurvy.[1] Evidence does not support use in the general population for the prevention of the common cold.[2][3] It may be taken by mouth or used by injection.[1]

It is generally well tolerated.[1] Large doses may cause gastrointestinal upset, headache, trouble sleeping, and flushing of the skin.[3][1] Normal doses are safe during pregnancy.[4] Vitamin C is an essential nutrient involved in the repair of tissue.[1] Foods that contain vitamin C include citrus fruit, tomatoes, and potatoes.[2]

Vitamin C was discovered in 1912, isolated in 1928, and first made in 1933.[5] It is on the World Health Organization's List of Essential Medicines, the most effective and safe medicines needed in a health system.[6] Vitamin C is available as a generic medication and over the counter.[1] The wholesale cost in the developing world is about 0.19 to 0.54 USD per month.[7] In some countries ascorbic acid may be added to foods such as breakfast cereal.[2]

Medical uses



Vitamin C supplements at a drug store

A 2012 Cochrane review found no effect of vitamin C supplementation on overall [8]

Scurvy

As a supplement it is used to treat and prevent scurvy.[7]

Cancer prevention

A 2014 review found that, "Currently, the use of high-dose [] vitamin C [as an] agent] cannot be recommended outside of a clinical trial."[9]

A 2013 Cochrane review found no evidence that vitamin C supplementation of lung cancer in healthy or high risk (smokers and asbestos-exposed) people meta-analysis found weak evidence that vitamin C intake might protect against risk.[11] A second meta-analysis found no effect on the risk of prostate cancer

Two meta-analyses evaluated the effect of vitamin C supplementation on colorectal cancer. One found a weak association between vitamin C consumption reduced risk, and the other found no effect of supplementation.[12][13]

A 2011 meta-analysis failed to find support for the prevention of breast cancer C supplementation,[14] but a second study concluded that vitamin C may increased survival in those already diagnosed.[15]

Cardiovascular disease

A 2013 meta-analysis found no evidence that vitamin C supplementation

myocardial infarction, stroke, cardiovascular mortality, or all-cause mortality.[17] However, a second analysis found an inverse relationship between circulating vitamin C levels or dietary vitamin C and the risk of stroke.[18]

A meta-analysis of 44 clinical trials has shown a significant positive effect of vitamin C on endothelial function when taken at doses greater than 500 mg per day. The researchers noted that the effect of vitamin C supplementation appeared to be dependent on health status, with stronger effects in those at higher cardiovascular disease risk.[19]

Chronic diseases

A 2010 review found no role for vitamin C supplementation in the treatment of rheumatoid arthritis.[20]

Studies examining the effects of vitamin C intake on the risk of Alzheimer's disease have reached conflicting conclusions.[21][22] Maintaining a healthy dietary intake is probably more important than supplementation for achieving any potential benefit.[23]

Vitamin C supplementation above the RDA has been used in trials to study a potential effect on preventing and slowing the progression of age-related cataract, however no significant effects were found from the research.[24]

Common cold

Further information: Vitamin C and the common cold

Vitamin C's effect on the common cold has been extensively researched. It has not been shown effective in prevention or treatment of the common cold, except in limited circumstances (specifically, individuals exercising vigorously in cold environments).[25][*needs update*][26] Routine vitamin C supplementation does not reduce the incidence or severity of the common cold in the general population, though it may reduce the duration of illness.[25][27]

Side effects

Common

Relatively large doses of ascorbic acid may cause indigestion, particularly when ta
empty stomach. However, taking vitamin C in the form of sodium ascorbate and ca
ascorbate may minimize this effect.[28] When taken in large doses, ascorbic acid ca
diarrhea in healthy subjects. In one trial in 1936, doses of up to 6 grams of ascorbi
were given to 29 infants, 93 children of preschool and school age, and 20 adults fo
than 1400 days. With the higher doses, toxic manifestations were observed in five
and four infants. The signs and symptoms in adults were nausea, vomiting, diarrh
flushing of the face, headache, fatigue and disturbed sleep. The main toxic reactio
infants were skin rashes.[29]

Possible

As vitamin C enhances iron absorption,[30][31] iron poisoning can become an issue
with rare iron overload disorders, such as haemochromatosis. A genetic condition
results in inadequate levels of the enzyme glucose-6-phosphate dehydrogenase (G
cause sufferers to develop hemolytic anemia after ingesting specific oxidizing sub
such as very large dosages of vitamin C.[citation needed]

There is a longstanding belief among the mainstream medical community that vit
causes kidney stones, which is based on little science.[32] Although recent studies
found a relationship,[33][34] a clear link between excess ascorbic acid intake and ki
stone formation has not been generally established.[35] Some case reports exist f
between patients with oxalate deposits and a history of high-dose vitamin C usag

In a study conducted on rats, during the first month of pregnancy, high doses of v
may suppress the production of progesterone from the corpus luteum.[37] Proges
necessary for the maintenance of a pregnancy, is produced by the corpus luteum
first few weeks, until the placenta is developed enough to produce its own source
blocking this function of the corpus luteum, high doses of vitamin C (1000+ mg)
theorized to induce an early miscarriage. In a group of spontaneously aborting w
the end of the first trimester, the mean values of vitamin C were significantly high
aborting group. However, the authors do state: 'This could not be interpreted as a
of causal association.'[38] However, in a previous study of 79 women with threate

previous spontaneous, or habitual abortion, Javert and Stander (1943) had 91% success with 33 patients who received vitamin C together with bioflavonoids and vitamin K (only three abortions), whereas all of the 46 patients who did not receive the vitamins aborted.[39]

A study in rats and humans suggested that adding Vitamin C supplements to an exercise training program lowered the expected effect of training on VO2 Max. Although the results in humans were not statistically significant, this study is often cited as evidence that high doses of Vitamin C have an adverse effect on exercise performance. In rats, it was shown that the additional Vitamin C resulted in lowered mitochondria production.[40] Since rats are able to produce all of their needed Vitamin C, however, it is questionable whether they offer a relevant model of human physiological processes in this regard.

A cancer-causing mechanism of hexavalent chromium may be triggered by vitamin C.[41]

Overdose

Vitamin C is water-soluble,[42] with dietary excesses not absorbed, and excesses in the blood rapidly excreted in the urine. It exhibits remarkably low toxicity. The LD_{50} (the dose that will kill 50% of a population) in rats is generally accepted to be 11.9 grams per kilogram of body weight when given by forced gavage (orally). The mechanism of death from such doses (1.2% of body weight, or 0.84 kg for a 70 kg human) is unknown, but may be more mechanical than chemical.[43] The LD_{50} in humans remains unknown, given lack of any accidental or intentional poisoning death data. However, as with all substances tested in this way, the rat LD_{50} is taken as a guide to its toxicity in humans.[*citation needed*]

In 2000 the Food and Nutrition Board of the National Academy of Sciences set a Tolerable Upper Intake Level (UL) of 2,000 mg/day. The amount was chosen because human trials had reported diarrhea and other gastrointestinal disturbances at intakes of greater than 3,000 mg/day. This was the Lowest-Observed-Adverse-Effect Level (LOAEL), meaning that other adverse effects were observed at higher intakes.[44]

Biological significance

Vitamin C is an essential nutrient for certain animals including humans. Vitamin C describes several vitamers that have vitamin C activity in animals, including ascorbic acid

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and its salts, and some oxidized forms of the molecule like dehydroascorbic acid.
Ascorbate and ascorbic acid are both naturally present in the body when either of
introduced into cells, since the forms interconvert according to pH. Vitamin C is a
in at least eight enzymatic reactions, including several collagen synthesis reaction
when dysfunctional, cause the most severe symptoms of scurvy.[45] In animals, this
reactions are especially important in wound-healing and in preventing bleeding fr
capillaries. Ascorbate also acts as an antioxidant, protecting against oxidative str

The biological role of ascorbate is to act as a reducing agent, donating electrons
enzymatic and a few non-enzymatic reactions. The one- and two-electron oxidized
vitamin C, semidehydroascorbic acid and dehydroascorbic acid, respectively, can
reduced in the body by glutathione and NADPH-dependent enzymatic mechanisms
The presence of glutathione in cells and extracellular fluids helps maintain ascor
reduced state.[49]

In humans, vitamin C is essential to a healthy diet as well as being a highly effec
antioxidant, acting to lessen oxidative stress; a substrate for ascorbate peroxidas
(APX is plant specific enzyme);[50] and an enzyme cofactor for the biosynthesis o
important biochemicals. Vitamin C acts as an electron donor for important enzy

Ascorbate is required for a range of essential metabolic reactions in all animals.
It is made internally by almost all organisms; the main exceptions are most bats
pigs, capybaras, and the Haplorrhini (one of the two major primate suborders, co
tarsiers, monkeys, and humans and other apes). Ascorbate is also not synthesize
species of birds and fish. All species that do not synthesize ascorbate require it

Deficiency

Main article: Scurvy

Scurvy is an avitaminosis resulting from lack of vitamin C, since without this
synthesized collagen is too unstable to perform its function.[45][52][50] Scurvy le
formation of brown spots on the skin, spongy gums, and bleeding from all mu
membranes. The spots are most abundant on the thighs and legs, and a perso
ailment looks pale, feels depressed, and is partially immobilized. In advanced
are open, suppurating wounds and loss of teeth and, eventually, death. The

store only a certain amount of vitamin C,[53] and so the body stores are depleted if fresh supplies are not consumed. The time frame for onset of symptoms of scurvy in unstressed adults on a completely vitamin C free diet, however, may range from one month to more than six months, depending on previous loading of vitamin C.

Western societies generally consume far more than sufficient vitamin C to prevent scurvy. In 2004, a Canadian Community health survey reported that Canadians of 19 years and above have intakes of vitamin C from food of 133 mg/d for males and 120 mg/d for females;[54] these are higher than the RDA recommendations.

Notable human dietary studies of experimentally induced scurvy have been conducted on conscientious objectors during WW II in Britain, and on Iowa state prisoners in the late 1960s to the 1980s. These studies both found that all obvious symptoms of scurvy previously induced by an experimental scorbutic diet with extremely low vitamin C content could be completely reversed by additional vitamin C supplementation of only 10 mg a day. In these experiments, there was no clinical difference noted between men given 70 mg vitamin C per day (which produced blood level of vitamin C of about 0.55 mg/dl, about 1/3 of tissue saturation levels), and those given 10 mg per day. Men in the prison study developed the first signs of scurvy about 4 weeks after starting the vitamin C free diet, whereas in the British study, six to eight months were required, possibly due to the pre-loading of this group with a 70 mg/day supplement for six weeks before the scorbutic diet was fed.[55]

Men in both studies on a diet devoid, or nearly devoid, of vitamin C had blood levels of vitamin C too low to be accurately measured when they developed signs of scurvy, and in the Iowa study, at this time were estimated (by labeled vitamin C dilution) to have a body pool of less than 300 mg, with daily turnover of only 2.5 mg/day, implying an instantaneous half-life of 83 days by this time (elimination constant of 4 months).[56]

Biosynthesis

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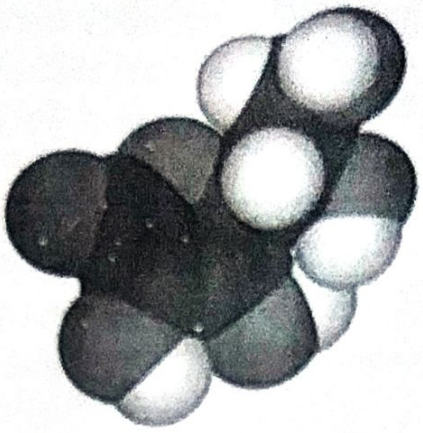

Model of a vitamin C molecule. Black is carbon, red is oxygen, and white is hydrogen

The vast majority of animals and plants are able to synthesize vitamin C, through a sequence of enzyme-driven steps, which convert monosaccharides to vitamin C. In this is accomplished through the conversion of mannose or galactose to ascorbic In some animals, glucose needed to produce ascorbate in the liver (in mammals and perching birds) is extracted from glycogen; ascorbate synthesis is a glycogenolysis dependent process.[58] In reptiles and birds the biosynthesis is carried out in the kidn

Among the animals that have lost the ability to synthesize vitamin C are simians and tarsiers, which together make up one of two major primate suborders, Haplorrhini. Th group includes humans. The other more primitive primates (Strepsirrhini) have the ab make vitamin C. Synthesis does not occur in a number of species (perhaps all specie the small rodent family Caviidae that includes guinea pigs and capybaras, but occurs other rodents (rats and mice do not need vitamin C in their diet, for example).[59]

A number of species of passerine birds also do not synthesize, but not all of them, an those that do not are not clearly related; there is a theory that the ability was lost sepa a number of times in birds.[60] In particular, the ability to synthesize vitamin C is presu to have been lost and then later re-acquired in at least two cases.[61]

All tested families of bats (Order Chiroptera), including major insect and fruit-eating families, cannot synthesize vitamin C. A trace of gulonolactone oxidase (GULO) was detected in only 1 of 34 bat species tested, across the range of 6 families of bats tes However, recent results show that there are at least two species of bats, frugivorous (*Rousettus leschenaultii*) and insectivorous bat (*Hipposideros armiger*), that retain th ability of vitamin C production.[63][64] The ability to synthesize vitamin C has also bee about 96% of fish (the teleosts).[60]

These animals all lack the L-gulonolactone oxidase (GULO) enzyme, which is required in the last step of vitamin C synthesis, because they have a differing non-synthesizing gene for the enzyme (Pseudogene ΨGULO).[65] A similar non-functional gene is present in the genome of the guinea pigs and in primates, including humans.[66][67] Some of these species (including humans) are able to make do with the lower levels available from their diets by recycling oxidised vitamin C.[68]

Most simians consume the vitamin in amounts 10 to 20 times higher than that recommended by governments for humans.[69] This discrepancy constitutes much of the basis of the controversy on current recommended dietary allowances. It is countered by arguments that humans are very good at conserving dietary vitamin C, and are able to maintain blood levels of vitamin C comparable with other simians, on a far smaller dietary intake.[70]

Like plants and animals, some microorganisms such as the yeast *Saccharomyces cerevisiae* have been shown to be able to synthesize vitamin C from simple sugars.[71][72]

Evolution

Ascorbic acid or vitamin C is a common enzymatic cofactor in mammals used in the synthesis of collagen. Ascorbate is a powerful reducing agent capable of rapidly scavenging a number of reactive oxygen species (ROS). Freshwater teleost fishes also require dietary vitamin C in their diet or they will get scurvy. The most widely recognized symptoms of vitamin C deficiency in fishes are scoliosis, lordosis and dark skin coloration. Freshwater salmonids also show impaired collagen formation, internal/fin hemorrhage, spinal curvature and increased mortality. If these fishes are housed in seawater with algae and phytoplankton, then vitamin supplementation seems to be less important, it is presumed because of the availability of other, more ancient, antioxidants in natural marine environment.[73]

Some scientists have suggested that loss of the vitamin C biosynthesis pathway may have played a role in rapid evolutionary changes, leading to hominids and the emergence of human beings.[74][75][76] However, another theory is that the loss of ability to make vitamin C in simians may have occurred much farther back in evolutionary history than the emergence of humans or even apes, since it evidently occurred soon after the appearance of the first primates, yet sometime after the split of early primates into the two major suborders

Ascorbate concentrations over the renal re-absorption threshold pass freely into the urine and are excreted. At high dietary doses (corresponding to several hundred mg/day in humans) ascorbate is accumulated in the body until the plasma levels reach the renal resorption threshold, which is about 1.5 mg/dL in men and 1.3 mg/dL in women. Concentrations in the plasma larger than this value (thought to represent body saturation) are rapidly excreted in the urine with a half-life of about 30 minutes. Concentrations less than this threshold amount are actively retained by the kidneys, and the excretion half-life for the remainder of the vitamin C store in the body thus increases greatly, with the half-life lengthening as the body stores are depleted. This half-life rises until it is as long as 83 days by the onset of the first symptoms of scurvy.[89]

Although the body's maximal store of vitamin C is largely determined by the renal threshold for blood, there are many tissues that maintain vitamin C concentrations far higher than in blood. Biological tissues that accumulate over 100 times the level in blood plasma of vitamin C are the adrenal glands, pituitary, thymus, corpus luteum, and retina.[90] Those with 10 to 50 times the concentration present in blood plasma include the brain, spleen, lung, testicle, lymph nodes, liver, thyroid, small intestinal mucosa, leukocytes, pancreas, kidney, and salivary glands.

Ascorbic acid can be oxidized (broken down) in the human body by the enzyme L-ascorbate oxidase. Ascorbate that is not directly excreted in the urine as a result of body saturation or destroyed in other body metabolism is oxidized by this enzyme and removed.

Enzymatic cofactor

Ascorbic acid performs numerous physiological functions in the human body. These functions include the synthesis of collagen, carnitine, and neurotransmitters; the synthesis and catabolism of tyrosine; and the metabolism of microsome.[49] During biosynthesis ascorbate acts as a reducing agent, donating electrons and preventing oxidation to keep iron and copper atoms in their reduced states.

Vitamin C acts as an electron donor for eight different enzymes:[51]

Three enzymes (prolyl-3-hydroxylase, prolyl-4-hydroxylase, and lysyl hydroxylase) that are required for the hydroxylation of proline and lysine in the synthesis of collagen.[91][92][93] These reactions add hydroxyl groups to the amino acids proline or lysine in the collagen

The North American Dietary Reference Intake recommends 90 milligrams per day for adult men, 75 mg/day for adult women, and no more than 2 grams (2,000 milligrams) per day.[104] There is continuing debate within the scientific community over the best dose schedule (the amount and frequency of intake) of vitamin C for maintaining optimal health in humans. A 2008 review recommended 1,000 mg/day as a supplement, in addition to what is consumed from food.[105] A balanced diet without supplementation usually contains enough vitamin C to prevent scurvy in an average healthy adult, while those who smoke tobacco or are under stress require slightly more.[104]

United States vitamin C recommendations[104]	
Recommended Dietary Allowance (adult male)	90 mg per day
Recommended Dietary Allowance (adult female)	75 mg per day
Recommended Dietary Allowance (pregnancy)	85 mg per day
Recommended Dietary Allowance (lactation)	120 mg per day
Tolerable Upper Intake Level (adult male)	2,000 mg per day
Tolerable Upper Intake Level (adult female)	2,000 mg per day

Recommended intake

Recommendations for vitamin C intake have been set by various national agencies:

40 milligrams per day or 280 milligrams per week taken all at once: the United Kingdom's Food Standards Agency[45]

40 milligrams per day as per the recommendations of India's National Institute of Nutrition, Hyderabad[106]

45 milligrams per day 300 milligrams per week: the World Health Organization[107]

80 milligrams per day: the European Commission's Council on nutrition labeling[108]

90 mg/day (males) and 75 mg/day (females): Health Canada 2007[109]

90 mg/day (males) and 75 mg/day (females): United States' National Academy of Sciences.[104]

Plant source	Amount (mg / 100g)
Grape	10
Apricot	10
Plum	10
Watermelon	10
Banana	9
Avocado	8.8[126]
Crabapple	8
Onion	7.4[127]
Cherry	7
Peach	7
Carrot	6
Apple	6
Asparagus	6
Horned melon	5.3[128]
Beetroot	5
Chokecherry	5
Pear	4
Lettuce	4
Cucumber	3
Eggplant	2
Raisin	2
Fig	2
Bilberry	1

Baobab	400
Chili pepper (green)	244
Guava (common, raw)	228.3[123]
Blackcurrant	200
Red pepper	190
Chili pepper (red)	144
Parsley	130
Kiwifruit	90
Broccoli	90
Loganberry	80
Redcurrant	80
Brussels sprouts	80
Wolfberry (Goji)	73 †
Lychee	70
Persimmon (native, raw)	66.0[124]
Cloudberry	60
Elderberry	60

† average of 3 sources; dried

Plant source	Amount (mg / 100g)
Papaya	60
Strawberry	60
Orange	53