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Study of the chemical composition of vitamin C

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Abstract
Vitamin C (ascorbic acid) is an essential biological compound with significant antioxidant properties, widely used in the food and pharmaceutical industries. In this study, the chemical structure and integrity of vitamin C were investigated by FTIR spectroscopy. FTIR analysis allowed the identification of characteristic functional groups, including hydroxyl (-OH) and carbonyl (C=O) groups, through specific signals in the infrared spectrum. The results revealed characteristic vibrations in the regions 3200–3600 cm^{-1} for O–H bonds and around 1750 cm^{-1} for C=O bonds, confirming the identity and purity of the sample. The study demonstrates that FTIR is a rapid, non-destructive and efficient method for the structural and qualitative analysis of vitamin C, providing valuable information for quality control and research of food and pharmaceutical products. Vitamin C contains the following functional groups: O-H, C=O, C-H and C-C.

Keywords: IR spectrum, vitamin C, composition, FTIR

Introduction
Vitamin C is a water-soluble vitamin, meaning that your body doesn't store it. You have to get what you need from food, including citrus fruits, broccoli, and tomatoes.
You need vitamin C for the growth and repair of tissues in all parts of your body. It helps the body make collagen, an important protein used to make skin, cartilage, tendons, ligaments, and blood vessels. Vitamin C is needed for healing wounds, and for repairing and maintaining bones and teeth. It also helps the body absorb iron from nonheme sources.
Vitamin C is an antioxidant, along with vitamin E, beta-carotene, and many other plant-based nutrients. Antioxidants block some of the damage caused by free radicals, substances that damage DNA. The build up of free radicals over time may contribute to the aging process and the development of health conditions such as cancer, heart disease, and arthritis.
It's rare to be seriously deficient in vitamin C, although evidence suggests that many people may have low levels of vitamin C. Smoking cigarettes lowers the amount of vitamin C in the body, so smokers are at a higher risk of deficiency [1-5].
Signs of vitamin deficiency include dry and splitting hair; gingivitis (inflammation of the gums) and bleeding gums; rough, dry, scaly skin; decreased wound-healing rate, easy bruising; nosebleeds; and a decreased ability to ward off infection. A severe form of vitamin C deficiency is known as scurvy.
Low levels of vitamin C have been associated with a number of conditions, including high blood pressure, gallbladder disease, stroke, some cancers, and atherosclerosis, the build up of plaque in blood vessels that can lead to heart attack and stroke. Getting enough vitamin C from your diet -- by eating lots of fruit and vegetables -- may help reduce the risk of developing some of these conditions. There is no conclusive evidence that taking vitamin C supplements will help or prevent any of these conditions.

Vitamin C plays a role in protecting against the following
- Results of scientific studies on whether vitamin C is helpful for preventing heart attack or stroke are mixed. Vitamin C doesn't lower cholesterol levels or reduce the overall risk of heart attack, but evidence suggests it may help protect arteries against damage.
Some studies -- though not all -- suggest that vitamin C can slow down the progression of atherosclerosis (hardening of the arteries). It helps prevent damage to LDL ("bad") cholesterol, which then builds up as plaque in the arteries and can cause heart attack or stroke. Other studies suggest that vitamin C may help keep arteries flexible [6-12].

In addition, people who have low levels of vitamin C may be more likely to have a heart attack, stroke, or peripheral artery disease, all potential results of having atherosclerosis. Peripheral artery disease is the term used to describe atherosclerosis of the blood vessels to the legs. This can lead to pain when walking, known as intermittent claudication. But there is no evidence that taking vitamin C supplements will help.

The best thing to do is get enough vitamin C through your diet. That way, you also get the benefit of other antioxidants and nutrients contained in food. If you have low levels of vitamin C and have trouble getting enough through the foods you eat, ask your doctor about taking a supplement.

- Population-based studies (which involve observing large groups of people over time) suggest that people who eat foods rich in antioxidants, including vitamin C, have a lower risk of high blood pressure than people who have poorer diets. Eating foods rich in vitamin C is important for your overall health, especially if you are at risk for high blood pressure. The diet physicians most frequently recommend for treatment and prevention of high blood pressure, known as the DASH (Dietary Approaches to Stop Hypertension) diet, includes lots of fruits and vegetables, which are loaded with antioxidants.
- Despite the popular belief that vitamin C can cure the common cold, scientific evidence doesn't support that theory. Taking vitamin C supplements regularly (not just at the beginning of a cold) produces only a small reduction in the duration of a cold (about 1 day). The only other piece of evidence supporting vitamin C for preventing colds comes from studies examining people exercising in extreme environments (athletes, such as skiers and marathon runners, and soldiers in the Arctic). In these studies, vitamin C did seem to reduce the risk of getting a cold.
- Results of many population-based studies suggest that eating foods rich in vitamin C may be associated with lower rates of cancer, including skin cancer, cervical dysplasia (changes to the cervix which may be cancerous or precancerous, picked up by pap smear), and, possibly, breast cancer. But these foods also contain many beneficial nutrients and antioxidants, not only vitamin C, so it's impossible to say for certain that vitamin C protects against cancer. Taking vitamin C supplements, on the other hand, has not been shown to have any helpful effect.

In addition, there is no evidence that taking large doses of vitamin C once diagnosed with cancer will help your treatment. In fact, some doctors are concerned that large doses of antioxidants from supplements could interfere with chemotherapy medications. More research is needed. If you are undergoing chemotherapy, talk to your doctor before taking vitamin C or any supplement.

- Vitamin C is essential for the body to make collagen, which is part of normal cartilage. Cartilage is destroyed in osteoarthritis (OA), putting pressure on bones and joints. In addition, some researchers think free radicals -- molecules produced by the body that can damage cells and DNA -- may also be involved in the destruction of cartilage. Antioxidants such as vitamin C appear to limit the damage caused by free radicals. However, no evidence suggests that taking vitamin C supplements will help treat or prevent OA. What the evidence does show is that people who eat diets rich in vitamin C are less likely to be diagnosed with arthritis.

Taking nonsteroidal anti-inflammatory drugs can lower your levels of vitamin C. If you take these drugs regularly for OA, you might want to take a vitamin C supplement [13-17].

- Vitamin C (500 mg) appears to work with other antioxidants, including zinc (80 mg), beta-carotene (15 mg), and vitamin E (400 IU) to protect the eyes against developing macular degeneration (AMD), the leading cause of legal blindness in people over 55 in the United States. The people who seem to benefit are those with advanced AMD. It isn't known whether this combination of nutrients helps prevent AMD or is beneficial for people with less advanced AMD. This combination includes a high dose of zinc, which you should only take under a doctor's supervision.
- Some studies suggest that taking vitamin C along with vitamin E may help prevent pre-eclampsia in women who are at high risk. Pre-eclampsia, characterized by high blood pressure and too much protein in the urine, is a common cause of premature births. Not all studies agree, however.
- Studies are mixed when it comes to the effect of vitamin C on asthma. Some show that low levels of vitamin C are more common in people with asthma, leading some researchers to think that low levels of vitamin C might increase the risk for this condition. Other studies seem to show that vitamin C may help reduce symptoms of exercise-induced asthma.

Materials and methods

FT-IR spectrum were accomplished and recorded with Fourier-Transform infrared spectrophotometer (Bruker, Alpha ATR) between 4000 and 375 cm-1, with resolution of 4 cm^{-1}.

Fig 1: Infrared spectrophotometer Bruker

Results and discussions

The peaks observed in 3550 cm − 3000 cm^{-1} region corresponds to the O-H band due to scissoring vibration of ascorbic acid. Additional peaks at 1654.6 cm^{-1} and 1326 cm^{-1} are due to C-C double bond stretch and the peak of the enol hydroxyl of ascorbic acid, indicative of crosslinking. The two peaks at 1692 cm^{-1} and 1743 cm^{-1} in the FTIR spectra of citric acid arise from the C=O (fig. 2).

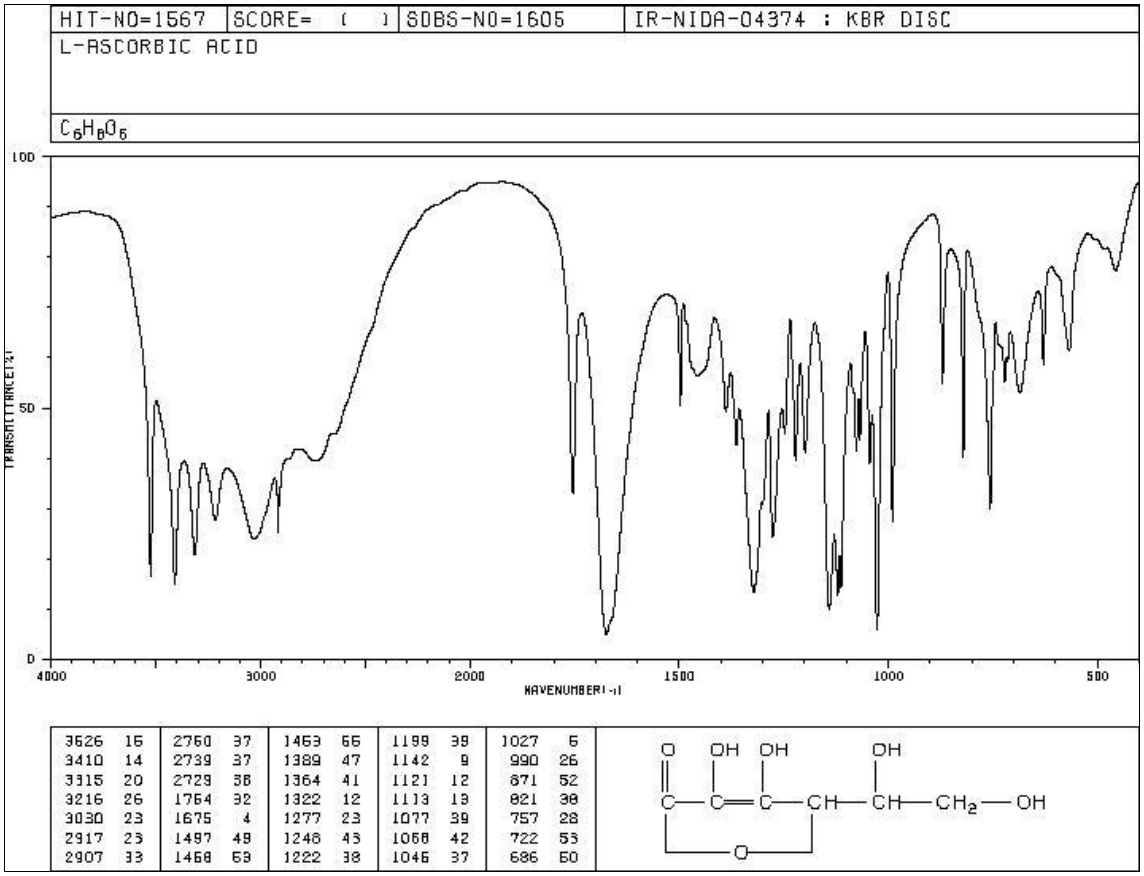

Fig 2: Spectrul IR vitamina C

Conclusions

FTIR spectroscopy allowed the precise identification of functional groups characteristic of vitamin C, including the hydroxyl (-OH) and carbonyl (C=O) groups. The vibrations observed in the regions 3200–3600 cm^{-1} (O–H) and approximately 1750 cm^{-1} (C=O) confirm the chemical structure and integrity of the sample. FTIR analysis has proven to be rapid, non-destructive and efficient for assessing the quality of vitamin C. The method can be successfully used in the quality control of pharmaceutical and food products containing vitamin C, providing relevant qualitative and structural information. The results obtained can serve as a reference for further studies on the stability and purity of vitamin C in different formulations.

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