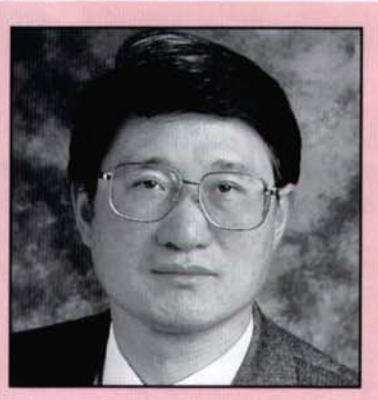
Vitamin C and skin health



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He has over 30 publications in many scientific journals and, as a result of his work, has been awarded several chemical patents. This article is a transcript of a lecture given at the CIDESCO International World Congress held in Athens in October 1998.

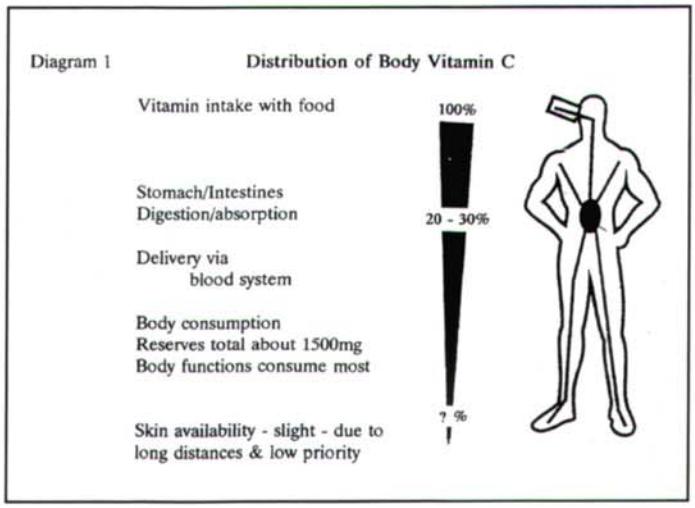
Vitamin C or Ascorbic acid exists naturally in many fruits and vegetables.

Oranges and tomatoes are particularly rich in the vitamin. Deficiency of vitamin C causes the disease scurvy, symptoms of which are bleeding of the gums and beneath the skin.

Pure Vitamin C can be made in the form of a dry powder which is fairly stable. In this form it can be stored for quite a long time in capsules, tablets or as the powder. Aqueous solutions of vitamin C are however easily oxidised by air and light turning a brownish colour. This liquid form of the vitamin is unstable and is difficult to use in cosmetic products.

Rather like vitamin E the absorption of vitamin C from the stomach and intestines is poor. Only 20 - 30% of the intake is absorbed and transported to the rest of the body by the blood system. The human body maintains a total pool of about 1,500mg of Vitamin C.

The vitamin is used primarily by bodily functions; however physical and emotional stress can use significant amounts of vitamin C. Smoking consumes a lot of extra vitamin.



Compared with a normal daily intake of 60mg smokers have been found to use 150mg and experts recommend an increased intake of 200mg is desirable for those who smoke. Thus it is easy to see how some smokers may easily and unknowingly suffer from vitamin C deficiency.

The amount of ingested vitamin C reaching the skin via blood circulation is very limited. The skin, and particularly the delicate facial skin, which is exposed to the environment is thus susceptible to vitamin C deficiency. Vitamin C can be absorbed through the skin and therefore topical application can have advantages.

The skin has an affinity for vitamin C and with a small molecular size (its molecular weight is only 176.12 and is less than that of citric acid) can easily be absorbed. After absorption the vitamin cannot be lost by washing or by perspiration and is effective for up to three days.

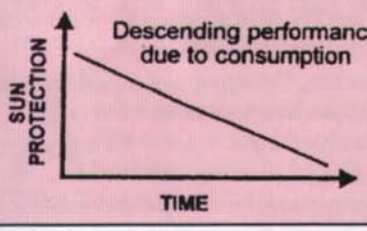
Vitamin C and the Sun. The vitamin is beneficial in both helping to prevent and to repair sun damage. Experimental work using comparable situations demonstrated much less damage to skin protected by the application of topical vitamin C. Similarly the application of topical vitamin C resulted in significantly faster healing of damaged skin.

Vitamin C can help protect the skin from sun damage but has a very different mechanism from the traditional sunscreen. (Diag. 2a) Sun protection by vitamin C decreases as time goes by because the vitamin is used up in the protection process. Just like an anti-oxident it is itself oxidised whilst it protects the skin. Thus the concentration of vitamin C will decrease and as it does so its protective ability also decreases.

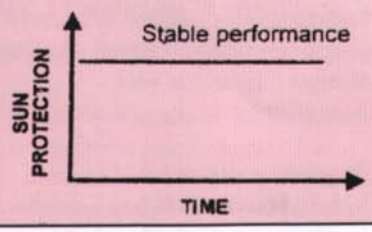
The sunscreen has a stable performance over time unless it is removed (Diag. 2b) - the sunscreen itself if not changed during the protection process. Once it is removed from the skin then the protection has gone. Vitamin C cannot be removed and its effect will remain until the concentration diminishes.

These two processes reveal the best way for the skin to be protected from sun - the combination of sunscreen and vitamin. Apply vitamin C to the skin first as an internal protection and then apply a sunscreen on the skin as an external protection. For instance with a sunscreen of SPF20 1/20th (ie. 5%) of the original UV light would go through the sunscreen and penetrate the skin. The internal vitamin C could take care of penetrating UV light very well. Vitamin C cannot replace sunscreen but it does provide excellent secondary sun protection.

Diag. 2a



Diag. 2b



Thus the skin can be very well protected. If no traditional sunscreen is used the vitamin C in the skin would be quickly used and its protective ability would rapidly decrease. If there is not vitamin C in the skin the sunlight passing through the sunscreen will cause damage.

It should be noted that any vitamin C not absorbed into the skin (ie. still in a cream or on the surface of the skin) does not provide any protection. Therefore a high concentration of vitamin C compound needs to be applied in an easily absorbed form as the first layer of protection. Vitamin C in any cream or sunscreen is not effective for sun protection because of poor penetration into the skin.

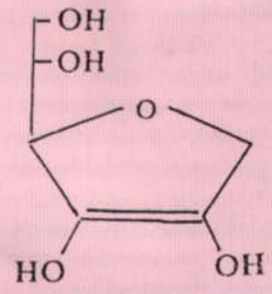
Vitamin C and its skin whitening effect. Hydroquinone is the traditional bleaching agent used in anti-pigmentation products. 2% hydroquinone is very popular and 4% strength is a prescription item used by dermatologists. In vitro experiments show that vitamin C has about 6% the bleaching capacity of hydroquinone. In other words a cream containing 10% vitamin C will be equivalent to 0.6% hydroquinone which has significant bleaching power to the skin particularly in long term use.

Hydroquinone is considered to be a carcinogen which can cause skin cancer. It use has been forbidden in many countries including Japan and Korea. At the present time hydroquinone can be legally used in the USA at a maximum concentration of only 2% in cosmetic products.

In addition to the possible carcinogenic effects hydroquinone products turn brown or dark brown. It is also difficult to keep hydroquinone products without colour change under normal storage conditions. Vitamin C does not have any side effects and can be used for long term application. A high concentration of the vitamin (>5%) has been found effective in preventing freckles and brown spots on the skin. Skintone can be noticeably improved usually after 2 weeks of daily use. The anti-pigmentation effect is of benefit to the skin and has been widely used in skin whitening and bleaching products.

The chemical structure of vitamin C. The structure of vitamin C provides clues to its properties.

Diagram 3a Molecular structure of Vitamin C (L-Ascorbic acid)



The double bond is unstable and easily attacked by oxidising substances.

The carbon to carbon double bond can very easily be oxidised to form a single bond. The double bond is the reason for the anti-oxidative properties of the vitamin and is also the source of its instability. It is impossible to change the nature of the double bond without altering the basic properties of Vitamin C and therefore other techniques have to be used to improve its stability. The trick is to attach a large chemical group in the position of the hydroxyl groups (-OH) near the double bond.

As a result oxidative substances - which would break the double bond - cannot gain access to the bond because of the blocking action of the attached group. In chemistry this is called Steric Hinderance.

If a large group is attached to the hydroxyl groups at the top of the molecule the steric hinderance effect is diminished because of the longer distance to the C=C double bond.

Palmitates are examples of substances which can be used to help block access to the double bond.

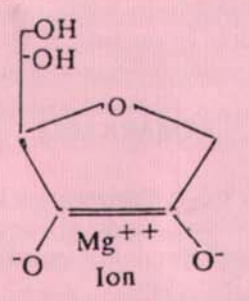
If one such group is attached to an hydroxyl in the top position and another to the right hand carbon of the double bond the stability is increased. This structure is ascorbyl dipalmitate.

Stability of the double bond has been increased but the presence of two palmitate groups has converted the previously hydrophilic hydroxyl groups of ascorbic acid to an oil soluble derivative. Note that only L-ascorbic acid (vitamin C) performs the beneficial skin functions.

The stable derivative has to be able to convert back to vitamin C in order to function properly within the skin.

Usually to provide the stability of ascorbic magnesium salts are attached by electrostatic bonding to the hydroxyl positions on the double bond forming derivatives called chelates.

Diagram 3B Stabilisation by the formation of a metallic chelate.



Magnesium ion blocks access to the vulnerable double bond

In this case the derivative magnesium ascobyl phosphate (or magnesium ascorbate) is formed.

The magnesium salts are hydrophilic and thus the vitamin C's magnesium chelates are also water soluble.

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Soaking up the spillages?

Whilst visiting your local hairdresser you may have given a passing thought to what happens to the volumes of hair that falls unwanted to the floor.

Should you have travelled in the orient the question may have been prompted more forcefully for there it seems that sweeping up is a "once at the end of a day" activity, whilst staff (and customers of the day) wade through rapidly increasing volumes of severed locks.

ECOLOGICAL USEFUL

A hairdresser in Alabama USA, Phil McCrory, may have stumbled upon an ecologically useful role for all those snippings.

He discovered, (we do not know how but suspect a salon accident) that a quarter of a pound weight of human hair will soak up and retain a gallon of oil in two minutes. (1 American gallon = 3.8 litres).

If this is possible he mused what could be achieved by using several thousands of pounds of hirsute waste if it were enclosed within nylon mesh bags.

REMARKABLE

America's NASA organisation is putting the idea through a series of scaled down "oil spillage" tests. Initial reports are, they say, "remarkable".

Admittedly calculations indicate that it would take some 70,000 kilograms (32,000 lbs) of hair to deal with a 1,000,000 litres oil spillage. (263,000 US gallons).

Nevertheless Mr. McCrory believes that sufficient quantities of unwanted hair - which is very compressible - could be collected if all hairdressers were provided with recyclable collecting bags.

When formulating stable compounds containing ascorbic acid the chemist needs to consider:-

1 Organic groups attached to hydroxyl positions on the C=C bond - such as ascorbyl dipalmitate - are hydrophobic.

2 Magnesium salts attached to an hydroxyl on the C=C bond such as magnesium ascobyl phosphate are hydrophilic.

3 Hydrophobic vitamin C derivatives are usually more stable because of a stronger co-valent bonding and tends to stay in the oily phase - it converts less easily back to the active vitamin C form.

4 Hydrophilic vitamin C derivatives, such as the magnesium compounds, are less stable than the hydrophobic forms but they can convert back to the active vitamin C much more easily.

Topical application of Vitamin C The key points for a good topical Vitamin C application are:-

1 A fairly stable vitamin C derivative otherwise the natural vitamin C will deteriorate quickly, become brown and produce an unpleasant odour.

2 The skin can only use natural vitamin C and therefore any stable derivative should easily convert back into vitamin C after being absorbed in the skin. Some hydrophilic vitamin C derivatives such as magnesium chelate have suitable stability and are able to easily release vitamin C within the skin. - There has to be a compromise between product stability and skin absorption.

3 Concentration is the driving force in chemistry. In general the higher the concentration the greater the effect or penetration. Research has revealed that a substantial concentration of vitamin C is needed to achieve a significant effect - particularly for sun protection. The concentration of Vitamin C in commercial products is recommended to be between 5 and 10%.

4 The pH of the skin is within the range 5.3 and 6.1. Vitamin C in aqueous solution is acidic and at 5% concentration results in a pH of 2.0. Just like AHA products a low pH could result in skin irritation or other side effects. The strength of topical vitamin C products is recommended to be within the pH range of 4.0 and 8.0.

A summary of the properties of vitamin C products for topical application are given in the chart below.

Topical vitamin C application

A desirable topical Vitamin C formula should:-

- Contain stable vitamin C derivative/s
- Be capable of being easily absorbed into the skin
- Also be able to easily reconvert into the natural and active Vitamin C form
- Have a minimum 5% concentration of active ingredient
- Have an appropriate Ph value (between 4.0 - 8.0) for safe and effective use

Topical Vitamin C benefits

A properly formulated topical Vitamin C product will provide a range of effective benefits to the user. These will include:-

1 Being an effective scavenger of oxygen free radicals
2 Helping to prevent and to repair sun damage
3 Helping to avoid hyper-pigmentation and to assist skin whitening
4 Having some influence on fibroblasts and on collagen generation and on the reduction of fine lines. (NOTE: this benefit is not as effective as the provided by AHA and/or retinoid treatments).

The application of a highly concentrated topical Vitamin C product should include:-

A morning and evening application. The product is gently massaged into the skin until dry. Then a cream or one's regular products may be used.

The skin will feel more silky within a few days and noticeably more smooth and radiant within two weeks. Improvement in skintone and fine lines are likely to be noticed after 4-5 weeks.