



Scurvy Science – Antiscorbutic Foods and Vitamin C

What is scurvy?

Scurvy is a disease caused by lack of vitamin C in the diet, causing symptoms of bleeding gums, painful joints and raised red lesions on the skin. Vitamin C is used along with an enzyme in the body to produce collagen. Collagen is like a protein 'glue', holding tissue together, especially when healing wounds. When collagen production is low due to vitamin C deficiency, tissues break down and severe cases of scurvy can result in death.

History of scurvy treatment on sea voyages

Many sailors died from scurvy on long voyages, until ship captains experimented with different types of food. On long sea voyages, they needed to carry preserved food rather than fresh food to prevent supplies from rotting. These preserved foods (such as dried ship's biscuit) contained low levels of vitamin C, so scurvy often developed in the crew. Certain foods called **antiscorbutics**, with high concentrations of vitamin C were experimented with during long voyages.

Vitamin C breaks down easily, particularly in warm environments, on exposure to air and in alkaline environments (such as during cooking). This caused problems during long voyages as the antiscorbutics gradually lost their nutritional value during storage.

Eventually, the Dutch, Germans and British worked out how to eliminate crew deaths from scurvy. The Dutch and Germans served 500 grams of raw or boiled sauerkraut per crew member twice a week. This seemed to be enough to ward off scurvy and was served more frequently when scurvy symptoms surfaced. James Lind from Scotland concluded in 1753 that lemon juice was an effective cure for scurvy and James Cook was renowned for convincing his crew to eat sauerkraut. Cook used a little psychology in persuading his crew to eat the sauerkraut by suggesting that it was only good enough for the officers. So, the lower ranked crew insisted that they should also receive a ration of sauerkraut!

Although they were not aware of the existence of vitamin C during the 18th century, they understood that antiscorbutic foods prevented the development of scurvy. Green vegetation such as grass was also collected on stops along the way to supplement their diet and were important supplies of vitamin C. For example, while Cook circumnavigated New Zealand in HMB *Endeavour*, they often stopped to collect wild celery and scurvy grass (*Lepidium oleraceum*), which were viewed as antiscorbutics. They also ate the young hearts of the cabbage palms (*Cordyline australis*) which contains significant amounts of vitamin C.

Antiscorbutics carried on HMB *Endeavour* included: malt, sauerkraut, marmalade of carrots, mustard, portable soup, rob of lemon and orange. The malt infusion was thought to be a good treatment for scurvy, but modern measurements show that it has a very low level of vitamin C. Rob of lemon is simply concentrated lemon juice. It was used sparingly on those who showed symptoms of scurvy. While limes and lemons have good vitamin C content, it tends to break down easily and degenerated over the course of the voyage. When sailing on HMS *Resolution* I and II, Cook stocked the same antiscorbutics as he had on HMB *Endeavour*. The malt was hopped on board and allowed to ferment into wort and evaporated into a thick syrup. The wort was mixed as one part to ten parts of water to form beer. Weekly antiscorbutics served included fermented or fresh cabbage and reconstituted portable broth with peas. The portable broth was reconstituted from a stored thick gel and cut with boiling water.

Vitamin C levels of foods

Listed below are the Vitamin C contents of foods which would have been consumed during a typical voyage. Values are in milligrams per 100 grams of food.

Lemon (raw, peeled)	= 48mg
Lemon juice concentrate	= 230mg
Lime (raw, peeled)	= 47mg
Sauerkraut	= 10 to 15mg
Cabbage (white, raw)	= 45mg
Cabbage (unsalted, boiled)	= 36mg
Biscuit (oatmeal, wheatmeal)	= 0mg
Malt	= 0.1mg
Whiting (fish raw or steamed)	= 1mg

The biochemistry of scurvy

When the body does not have enough vitamin C, collagen is not produced properly. This causes blood capillaries to haemorrhage blood and cause weakness and joint pain. Raised red spots on the skin turn into lesions after five months of a lack of vitamin C. Teeth become loose and gums bleed – making it difficult to eat. Eventually – the body's tissues break down and the sufferer may die. As well as preventing tissue breakdown, vitamin C helps the body to absorb iron. While vitamin C has been popularly suggested to prevent colds and flu, it has not yet been scientifically proven.

The chemical name for vitamin C is ascorbic acid. Ascorbic acid is water soluble and is absorbed into the blood in the upper part of the small intestine and excreted in the urine.

Humans need less than 300mg of vitamin C stored in their body before scurvy will develop. Depending on age and pregnancy, recommended vitamin C intakes range from 30 to 95mg per day. Vitamin C poisoning can occur in humans if too much is consumed. The upper safe limit is about 2 000mg for adults.

Normally, ascorbic acid is synthesised from simple sugars by plants and most animal species. Only humans, monkeys, guinea pigs, fruit eating bats, and two species of Indian birds do not have the enzyme to produce vitamin C or ascorbic acid and must obtain it from their diet.