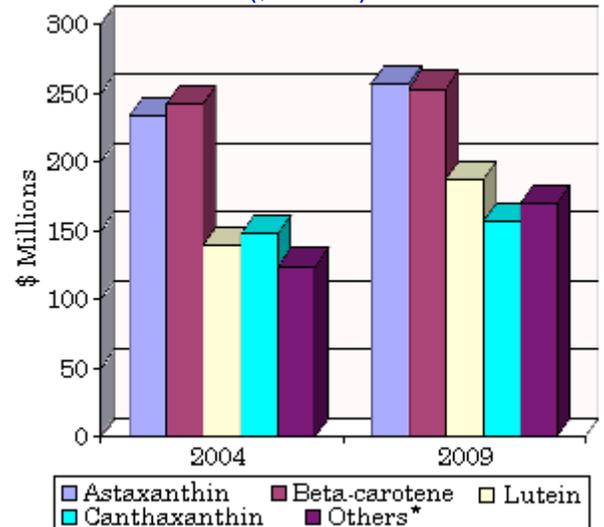


REPORT HIGHLIGHTS

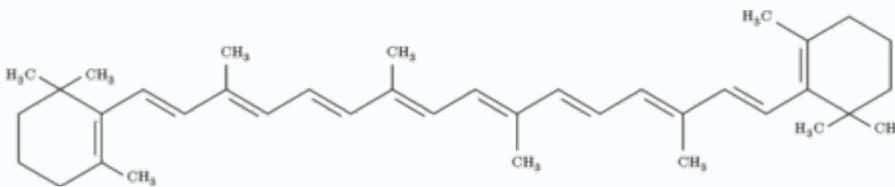
- The current worldwide market value of all commercially-used carotenoids is estimated at \$887 million for 2004 and expected to rise at an average annual growth rate (AAGR) of 2.9% to just over \$1 billion.
- The largest outlet will remain feed, mainly because of the outstanding importance of astaxanthin and canthaxanthin.
- The market value of beta-carotene was estimated at \$242 million in 2004. Increasing competition from Asia has resulted in price pressure that will result in a very moderate 2.9% AAGR through 2009. Food still is the most important outlet, where it is widely used as a color.
- The big marketing success of recent years is lutein when it was demonstrated that it could help reduce age-related macular degeneration. This pushed lutein's market value up to \$139 million in 2004.

Global Carotenoid Market by Product, 2004 and 2009
(\$ Millions)



* Includes Lycopene, Annatto, Zeaxanthin, Apo-carotenal and Apo-carotenal-ester.
Source: BCC Research

Carotene



 β -carotene

β -carotene can be found in [yellow](#), [orange](#), and [green leafy fruits](#) and [vegetables](#). These can be carrots, [spinach](#), [lettuce](#), [tomatoes](#), [sweet potatoes](#), [broccoli](#), [cantaloupe](#), [orange](#), and [winter squash](#). As a [rule of thumb](#), the greater the intensity of the color of the fruit or vegetable, the more β -carotene it contains.

β -carotene is an [anti-oxidant](#) and such can be useful for curbing the excess of damaging [free radicals](#) in the body. However, the usefulness of β -carotene as a [dietary supplement](#) (i.e. taken as a pill) is still subject to debate. β -carotene is [fat-soluble](#), so a small amount of fat is needed to absorb it into the body.

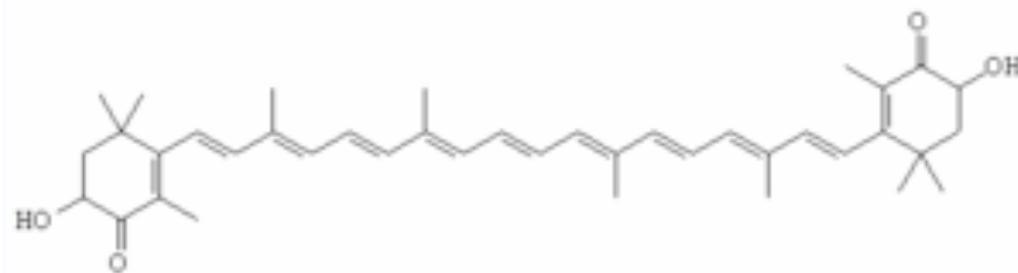
namely bronzing of the skin ([carotenodermia](#)). The normal levels of Lutein found in a daily vitamin tablet can be as low as 0.25mg.

The functional difference between the benefits of lutein and lutein esters is not entirely known. It is suggested that the [bioavailability](#) is lower for lutein esters, but much debate continues.

Commercial value

The commerciality of lutein has recently exploded with an estimated market value of \$139 million in 2004, compared to \$64 million in 1999. It is one of the fastest growing areas of the \$887 million carotenoid market. There are several lutein ester suppliers, but few pure lutein suppliers due primarily to patent protections on obtaining purified lutein from natural products, namely marigolds. Nevertheless, the market value of lutein is anticipated to grow at an average annual growth rate ([AARP](#)) of over 6%.

Astaxanthin



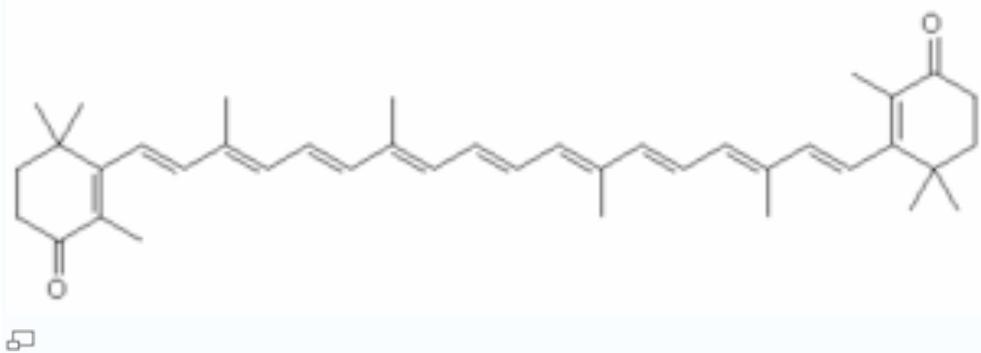
Astaxanthin (pronounced as-tuh-zan'-thin) is a [carotenoid](#). It belongs to a larger class of [phytochemicals](#) known as [terpenes](#). It is classified as a [xanthophyll](#), which means 'yellow leaves'. Like many carotenoids, it is a colorful, fat/oil-soluble [pigment](#). Astaxanthin can be found in microalgae, yeast, [salmon](#), [trout](#), [krill](#), [shrimp](#), crayfish, crustaceans and the feathers of some birds. [1][2] Professor [Basil Weedon](#) was the first to map the structures of astaxanthin.

Astaxanthin, unlike some carotenoids, does not convert to [Vitamin A](#) (Retinol) in the human body. Too much Vitamin A is toxic for a human, but astaxanthin is not. However, it is a powerful [antioxidant](#). It is 10 times more capable than other carotenoids.[3]

While astaxanthin is a natural nutritional component, it can be found as a food supplement. The supplement is intended for human, animal and [aquaculture](#) consumption. The commercial production of astaxanthin comes from both natural and synthetic sources.

The [FDA](#) approved astaxanthin - as a [food coloring](#) (or color additive) for specific uses in animal and fish foods. The [European Union](#) considers it [food dye](#).

Canthaxanthin



Canthaxanthin is a [food additive](#) used for farmed [salmon](#) raised in environments where [astaxanthin](#) sources are not available. Canthaxanthin gives salmon a pink color similar to [pink/red](#) species of wild salmon, while at the same time acting as an [antibiotic](#).

Canthaxanthin is a permitted color additive in foods and animal feeds in many countries including the Mainland, EU, US and Canada.

In the United Kingdom, Canthaxanthin is allowed by law to be added to poultry feed, some sausages mainly exported to France, and trout and salmon feed.

Health concerns have raised the issue of safety concerning the usage of canthaxanthin in commercially sold salmon. As a result, in the [United States](#), food packaging must indicate if [artificial coloring](#) (including, but not limited to canthaxanthin) is added to the fish. In addition, the [European Union](#) has set limits on how much canthaxanthin commercially sold fish may contain.

The analysis of canthaxanthin content in salmon is a scientifically-accepted method to determine the origin of salmon.

Canthaxanthin capsules were also used extensively in the [1990s](#) as a "tanning pill" since the substance would accumulate in the fatty tissue immediately underneath the skin, resulting in a reasonable facsimile of a natural sun tan. Such usage declined — but has not disappeared entirely — after the [Food and Drug Administration](#) in the [United States](#) withdrew approval of its use for this purpose in [1999](#), citing cases of [color blindness](#) and related visual difficulties, resulting from the fact that the substance can become lodged in the [retina](#); vision does return to normal after use is discontinued in most cases, however.