

The Sulforaphane Story

Q & A



SULFORAPHANE

..... Answers to Common Questions

Q 1. What is Sulforaphane?

A. Sulforaphane is a compound formed in plants of the Broccoli vegetable family. The vegetables of this plant family are known as *Cruciferous Vegetables*. Sulforaphane has been extensively researched for its health-promoting benefits.

Q 2. How much Sulforaphane is found in Broccoli?

A. In fact, there is *no* Sulforaphane *found in* Broccoli or any other Cruciferous Vegetable. The plant cell contains 2 different types of sacs that contain the 2 substances that produce Sulforaphane – but only when they are mixed together.

When the plant is cut or chewed, the contents of the 2 sacs combine, producing a chemical reaction that leads to the production of the Sulforaphane.

Sulforaphane itself is not stable for longer than about 30 minutes; therefore, the Sulforaphane must be produced just before consuming the broccoli.

It is the effect of the enzyme, *Myrosinase* in one sac on the *Glucoraphanin* compound in the other sac that produces the Sulforaphane.

Q 3. Why don't the 2 sacs react in a powdered broccoli product, given that the powder been produced by milling the plant and the sacs must have already broken?

A. Enzymes such as *Myrosinase* can only react when they are in contact with water. Because the powder is dry, there can be no reaction. However, when the powder is added to a glass of water, the chemical reaction begins immediately and the sulforaphane is produced. For a capsule, as soon as the capsule has dissolved, the powder is exposed to the moisture in the digestive tract; the same conversion process occurs and Sulforaphane is produced.

Q 4. What happens to the Sulforaphane if I mix the powder in water and leave the glass on the bench or in the fridge?

A. Sulforaphane is only stable over a short period, so it always wise to consume the mixture as soon as possible and certainly within 30 minutes of mixing.

Q 5. Is broccoli the best source of Sulforaphane?

A. The highest source of Sulforaphane is not the broccoli *vegetable*. The highest source is the broccoli *sprout*, which is between 20-50 times higher in Sulforaphane than the mature vegetable. For

this reason, Broccoli Sprouts have been actively researched as a source of the cell-protective bioactive compound, Sulforaphane.

Q 6. Why are Cruciferous vegetables considered so important?

A. Health authorities across the world encourage us to consume more vegetables, recommending at least 5 serves of vegetables daily plus 2 serves of fruit. Research shows that, of all vegetables, the cruciferous vegetables have the most protective effect against humans developing serious illness. When we select vegetables, we should regularly include this family of vegetables.

Q 7. Do most people eat Cruciferous vegetables?

A. Actually, of all the vegetables we could choose to eat, the very valuable cruciferous vegetables like broccoli make up less than 1% of average consumption. Clearly, most people are not taking advantage of the benefits of this well-researched vegetable.

Q 8. What does Sulforaphane do?

A. Sulforaphane is a small molecule that is easily taken up by human cells. Once inside the cells, it acts as a '*signalling molecule*', sending messages to other parts of the cell.

One of Sulforaphane's most important functions is that it activates a '*switch*' within the cell. This '*switch*' (a *special molecule known as Nrf2*) releases a small fragment which then travels into the nucleus, the part of the cell in which the genes are housed.

Once inside the nucleus, it locates the genes of the cell's internal defence activities. In some cases, the DNA in sections of these genes can be completely '*switched off*'; in other cases, the genes may be just '*lazy*' or '*sleepy*'. Certainly as we age or are unwell, the activity of these genes declines. In any case, Sulforaphane is capable of restoring the gene's activity towards normal.

Q 9. How many different genes does Sulforaphane influence?

A. To date, Scientists have found that there are around 2000 genes of the cell's defence system known to be influenced by Sulforaphane.

Q 10. What is meant by the 'Cell's Defence System'?

A. Our body cells use many different processes to defend themselves against attack. Two of the most important of these protective processes are:

- **ANTIOXIDANT BALANCE** To provide the appropriate level of Antioxidant *balance* to stop free radicals from damaging the cell's delicate systems.
- **DETOXIFICATION** To produce specialised *Detoxification Enzymes* that break down toxins quickly, before they have a chance to damage the cell.

If these two fundamental mechanisms can be optimised within cells, the cell is likely to function normally. If the cells are healthy, then the individual will be healthy. This is why health care should ideally begin by correcting imbalances within the cells.

Q 11. What is a 'free radical'?

A. A 'free radical' is a chemical substance that is very unstable, usually because it is missing an electron in its outer layer. To try to become stable again, it attacks other chemicals, 'stealing' an electron from this other substance. This now makes the other substance unstable, so that it becomes a free radical itself.

Uncontrolled, this creates a *chain reaction* of free radical activity and this chain reaction leaves a trail of damage wherever it goes. In human cells, the effect of such uncontrolled free radical activity is to damage the cell's delicate structures. Many diseases are known to be associated with free radical damage. Scientists call this *Oxidative Stress*.

Q 12. Where do free radicals come from?

A. Free radicals are found all around us in the environment in the form of pollution, radiation, hazardous chemicals, barbecued meat, cigarette smoke and so on.

What is not so well-known is that our own cells are constantly producing large amounts of free radicals. These are produced just by eating, breathing and moving! They are a normal part of our existence. Not all free radical activity is harmful and the body uses them to send signals to other parts of the cells.

It is when they are *uncontrolled* that they are dangerous to our health. This state of uncontrolled activity is what we call *Oxidative Stress*.

Q 13. How do humans deal with Oxidative Stress?

A. Nature has provided the cell with a series of Antioxidant Enzymes whose task it is to quench (or neutralise) excessive free radical activity. These are very powerful antioxidants. The healthy cell also produces a constant supply of another Antioxidant compound, *Glutathione* that bathes every part of the cell. Glutathione is also essential in the detoxification of drugs like paracetamol.

Yet other kinds of Antioxidants are found in food, especially in brightly-coloured fruits and vegetables. One of the reasons that Nutritionists recommend that we regularly consume a wide variety of brightly-coloured fruits and vegetables is so that we can obtain a variety of these Antioxidant compounds.

These food-derived Antioxidants have their most beneficial effects in the digestive tract, neutralising the free radicals so commonly found in cooked, processed and preserved foods. Quenching free radicals in the digestive tract minimises the numbers of these harmful substances entering the bloodstream. This is why it is a good idea to consume brightly-coloured fruits and vegetables with a meat-containing meal or other foods such as deep fried foods where there is likely to be increased free radical activity

Q 14. What types of Antioxidants are increased under the influence of Sulforaphane?

A. One of the most important antioxidant molecules increased because of Sulforaphane's presence in the cell is *Glutathione*. Glutathione is a bit like an 'antioxidant bath' within the cell. As long as there is adequate Glutathione in the cell, it is protected against many potentially-damaging molecules.

Sulforaphane stimulates the production of many other Antioxidant compounds, each of which plays a special role in protecting the cell. Some of these other Antioxidant Enzymes stimulated by Sulforaphane have protective effects in specific types of cells such as nerve cells and heart cells.

The ideal Antioxidant support for human cells is a combination of brightly-coloured fruits and vegetables together with Sulforaphane-induced *Glutathione* and associated Antioxidant compounds produced within healthy cells.

Q 15. Why can't I just take Antioxidant supplements like Vitamin C?

A. The Antioxidants produced naturally within the cell are many times more powerful than Vitamin C and other Vitamin-based Antioxidants. The cell's Antioxidant compounds are targeted at particular types of free radical and very efficiently bring them under control.

Molecules like Vitamin C are designed to do other jobs in the cell and although they can neutralise some types of free radical, compared with the ones produced within the cell, they are not very efficient at doing so. Some authorities suggest using megadoses of Vitamin C to control free radical activity but this has been shown to be a very inefficient way of dealing with Oxidative Stress. It is a bit like using a scattergun approach to hit the bullseye when one well-directed bullet will hit the target!

Q 16. Why not just eat broccoli vegetable more often?

A. You could do this and Science has shown that individuals who consume the highest amounts of the vegetable are less likely to develop certain illnesses.

However, in practice, many people simply don't eat enough broccoli to make a difference. More importantly, cooking the broccoli destroys the *Myrosinase* enzyme so essential for the conversion to Sulforaphane. Because the broccoli sprout is so much more concentrated than the vegetable, only a small amount of the sprout is needed daily to achieve what a large amount of raw or lightly-steamed broccoli vegetable could do.

The powdered broccoli sprout provides a more consistent amount of the bioactive potential because it is produced using conditions to standardise it. The broccoli vegetable supplies unpredictable amounts due to the variety of broccoli seed used, the conditions in which the plant is grown, the time it is stored before consumption and the manner in which it is cooked. A more certain intake occurs when consuming a regular quantity of a premeasured powder – or capsule.

Q 17. I've heard that some Antioxidants are rated by their ORAC Value. What is this?

A. 'ORAC' stands for *Oxygen Radical Absorbance Capacity*. This is a laboratory measurement to determine how well the food molecules can quench free radicals in a test tube. Some of the so-called 'super fruits' are known to have very high ORAC values and this can be valuable when quenching the free radicals in food. This test *tells of nothing* of how well these antioxidants might perform in the body's cells!

More importantly, ORAC is not able to measure the Antioxidant capacity of the much more powerful Antioxidants we produce in our own cells. Foods like broccoli sprouts which are capable of activating our own Antioxidant-generating 'machinery' don't have high ORAC values.

What this means is that although ORAC can be a useful way of comparing the effect of different fruits and vegetables in the digestive tract, it is not able to measure the more powerful effect within the cells.

Where ORAC can be useful is that it can tell us that blueberries for example have a higher ORAC value than apples and that fruits like Amalaki, Acai and Pomegranate have very much higher ORAC values than most if not all other fruits.

Sulforaphane's far more powerful effect in generating cellular Antioxidants cannot be measured by ORAC. The ORAC test therefore gives a very misleading idea of the value of a food based on its Antioxidant capacity.

SPECIAL NOTE: Nutritional Science has now moved beyond the ORAC concept and the science behind Sulforaphane confirms that. Because the ORAC value was being used to promote certain exotic berries and other fruits, the United States Department of Agriculture (USDA) completely removed ORAC tables from its website.

Q 18. Sulforaphane activates the cell's Detoxification Enzymes. What does this mean?

A. All cells produce waste materials during their ordinary day-to-day activities. These wastes will poison the cell if it doesn't detoxify and then eliminate them. Some of these waste products are so toxic that they must be neutralised before they can be passed out of the body. If these toxins aren't controlled, continued cell damage will eventually lead to disease.

Of course, there are many toxic compounds to which we are continuously exposed. These are most frequently in the form of pesticide residues in food and water and pollutants in the air.

The *Detoxification Enzymes* are Nature's way of dealing with these toxic molecules. These are a family of enzymes all specifically targeted at modifying the chemical structure of toxic molecules so that they can no longer damage cell structures.

Research over the past 25 years has shown that the most powerful known natural substance capable of 'switching on' or 'upregulating' these Detoxification Enzymes is Sulforaphane.

This fact, coupled with its ability to enhance the cell's Antioxidant status, means that Sulforaphane is one of the most valuable food-derived compounds available for enhancing the defence mechanisms of human cells.

Q 19. I've heard that Sulforaphane is considered a substance with nutrigenomic effects. What does that mean?

A. The DNA in our cells contains all of the genetic information we inherited from our parents. Although we can't change genetically-determined factors like our height and eye colour, there are many aspects of our genetic make-up that we can change.

For example, we might believe that we have inherited a high risk of developing heart disease from our parents because one or both parents may have had this condition. However, it is very well-known that the risk of heart disease is closely related to our diet and lifestyle. A lifestyle based on a poor diet and little exercise is likely to lead to heart disease whether or not we have inherited predisposing genes from our parents!

So what do we have the power to change? Quite simply, a change of diet means that there are different food chemicals entering our cells. These food molecules can interact with our DNA and cause the DNA to be *expressed* in particular ways. Poor diet sends signals to our DNA that tend to *shut down* our cell's internal defence processes. This, in time leads to the development of disease.

The chemicals in a *healthy* diet send different signals to our DNA. We have already seen that Sulforaphane activates the 'switch' in the cell that activates the cell's internal defences. Sometimes, we say that '*Sulforaphane talks to our DNA*'.

We say that a substance that is capable of favourably interacting with our cellular DNA has an *epigenetic effect*. Sulforaphane has a *nutrigenomic effect*.

To use the computer as an analogy, a *nutrigenomically-active* substance does not modify the DNA structure itself (the 'hardware') but it affects the way in which genes may be expressed. We might consider this to be like the 'software' of the gene. We can quite readily modify the 'operating system' software but we can't change the hardware of the computer. So, although we inherit certain genetic characteristics that are *hard-wired* into our genes, we can influence the software of our DNA by the type of food and lifestyle data we 'key in' to our genes.

Changes in the *expression* of certain genes can affect the efficiency of many cellular processes, such as how readily we can detoxify alcohol or caffeine. It might also affect how quickly we recover from an injury or how quickly we age. These subtle changes in gene expression can be the difference between living a long and healthy life or in merely *existing* with a range of symptoms and illnesses that seriously compromise the quality of life.

Nutrigenomics teaches us that food is not just a mixture of calories, proteins, vitamins, minerals and so on. Food is a dynamic 'cocktail' of thousands of different chemical substances that interact to varying degrees with the cell's DNA. Even small amounts of *phytochemicals* (or plant chemicals) can have very powerful effects within the cell as they send signals that determine how a cell functions.

This new and exciting branch of Nutritional Science opens up a whole new arena of personal health care, whereby individuals can take back control of their own health by carefully selecting foods for their *nutrigenomic* advantage.

Q 20. I've heard that sulforaphane from broccoli sprouts can help control *Helicobacter pylori* infection of the stomach. How does this work?

Helicobacter pylori (or *H. pylori*) is a bacterium that burrows into the lining of the stomach where it is capable of reducing the stomach acid needed for normal digestion - and further leading to the development of stomach ulcers and eventually to stomach cancer. An *H. pylori* infection is typically medically treated with an antibiotic 'cocktail' containing three very strong drugs; this is known as 'Triple Therapy'.

Although Triple Therapy may provide temporary relief, it usually doesn't eradicate the bacteria, which eventually start to multiply again. Such concentrated antibiotic therapy doesn't just kill off *H. pylori*; it kills off a large proportion of the health-promoting bacteria that inhabit the digestive tract, the microbiota.

Several clinical trials have shown that Sulforaphane is capable of destroying *H. pylori*, without adversely affecting the microbiota. It does this in two different ways: as described earlier, by improving the defences of human cells as a whole, the cells of the intestine can 'fight off' *H. pylori* by naturally enhancing the cellular defence processes.

The second way that Sulforaphane eradicates *H. pylori* is because it can break down a key enzyme that the bacterium makes itself. This enzyme is needed so that *Helicobacter* can create its preferred non-acidic environment in the lining of the stomach. When Sulforaphane destroys this enzyme, known as *urease*, *Helicobacter* cannot survive and it gradually dies off.

Luckily the studies that have been done show that about 35 mg of sulforaphane daily¹ is the dose that controls *H. pylori*. Depending on other factors within each individual, *H. pylori* may or may not return. Nevertheless, it is a safe, natural way of controlling what is a potentially serious infection and, at the same time, Sulforaphane provides numerous other benefits.

¹ **SPECIAL NOTE:** Reference to 35 mg sulforaphane is not the same as '*sulforaphane glucosinolate*'; this is sometimes shown in abbreviated form as 'SGS'. Some broccoli sprout supplements are labelled in this way, such that one might think that such a supplement is a source of bioactive Sulforaphane; it is not. The term '*sulforaphane glucosinolate*' is simply a marketing term which refers to 'glucoraphanin'. Without the myrosinase enzyme, the product does not yield any Sulforaphane when ingested.

SUMMARY

Sulforaphane is a substance derived from consuming broccoli and in particular broccoli sprouts. Sulforaphane is only produced when a chemical reaction occurs between two substances found naturally in the intact plant; the sulforaphane-containing product must be consumed within 30 minutes of mixing.

Sulforaphane is considered a major reason that cruciferous vegetables are so beneficial to health and capable of preventing many forms of disease. In spite of their well-researched value in human health, they are not popular food choices.

Cells are naturally equipped with their own internal Defence System. Much of the cell's ability to defend itself is due to 2 main factors:

- its ability to produce the Antioxidants that quench harmful free radicals
- its ability to produce Detoxification Enzymes to break down toxins.

Remarkably, Sulforaphane can enhance both of these key defence processes. It does this by activating a compound within the cell that then '*switches on*' or '*upregulates*' around 2000 *defence* genes.

Regular intake of Sulforaphane-yielding broccoli sprouts provides a simple way of enhancing these processes, which naturally decline as we age or are unwell.

Clinical trials have been conducted on Sulforaphane in a number of different conditions; one condition for which Sulforaphane has been shown to be of value is in controlling the *Helicobacter pylori* that contributes to stomach ulcers and other more serious consequences of such infections.