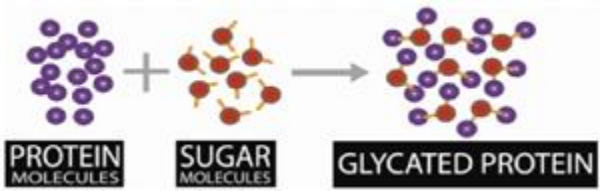
Live Longer By Reducing Glycation

The harm caused by glycation inside your body is very underrated and very overlooked when it comes to general good health and longevity. In fact, glycation is at the root of many diseases, pre-mature aging and a shorter life, yet glycation is easily prevented. Here is a quote from Wikipedia: "Glycation is implicated in many age-related chronic diseases such as cardiovascular diseases (the endothelium, fibrinogen, and collagen are damaged), Alzheimer's disease (amyloid proteins are side-products of the reactions progressing to AGEs), cancer (acrylamide and other side-products are released), peripheral neuropathy (the myelin is attacked), and other sensory losses such as deafness (due to demyelination). This range of diseases is the result of the very basic level at which glycations interfere with molecular and cellular functioning throughout the body and the release of highly oxidizing side-products such as hydrogen peroxide. Long-lived cells (such as nerves and different types of brain cell), long-lasting proteins (such as crystalline of the lens and cornea), and DNA may accumulate substantial damage over time. Cells such as the retina cells in the eyes, and beta cells (insulin-producing) in the pancreas are also at high risk of damage from glycation. Damage by glycation results in stiffening of the collagen in the blood vessel walls, leading to high blood pressure, especially in diabetes. Glycations also causes weakening of the collagen in the blood vessel walls, which may lead to strokes". What exactly is glycation?

When you eat food some of it converts to glucose molecules in the blood, and then some of those glucose molecules will bond with proteins that are also circulating in the bloodstream. These blood proteins can be chains of amino acids or they can be protein capsules containing lipids. For simplicity we will refer to them both as 'proteins' or 'blood proteins'.



Glycation occurs when glucose molecules bond with proteins in the blood, forming what is known as AGEs (Advanced Glycation End-products). Put simply glycation causes damaged proteins.

These AGEs (damaged proteins) then circulate in the blood and generate very harmful free radicals known as ROS (Reactive Oxygen Species) that affect all parts of the body. These ROS free radicals bump into body cells just about everywhere the blood stream goes, causing cellular damage. Once damaged, the cells become susceptible to oxidative stress and mutate or die. Hence, glycation and oxidative stress very much go hand in hand.

"AGEs block nitric oxide activity in the endothelium and cause the production of reactive oxygen species". Source: Alison Goldin, et al, Advanced Glycation End Products, Basic Science for Clinicians, http://circ.ahajournals.org.

"AGEs affect nearly every type of cell and molecule in the body and are thought to be one factor in aging and some age-related chronic diseases" (Wikipedia).

The sequence of events is roughly as follows:

Food consumption, blood glucose, blood proteins, glycation of proteins ► ► ► ► AGEs ► ROS free radicals ► cellular damage ► oxidative stress ► cellular death/mutation ► disease ► poor health.

Glycation is also the main reason your skin becomes old and wrinkled, and more susceptible to skin cancer. What happens is that glucose molecules come into contact with protein molecules (i.e. collagen) contained in the scaffold below the skin.

Incidentally, taking collagen supplements that you swallow have no effect on improving your skin. Nor do they help with healing and repairing damaged bones. They should be completely avoided as they increase the risk of harmful calcification in your body.

We cannot avoid glycation in our lives because when we eat, this creates proteins in the blood that become a target for glycation. We need to minimize the chances that a glucose molecule will bump into a protein molecule and bond. We do this by minimizing the amount of proteins and/or glucose molecules circulating in the blood.

In a healthy body this low level of glycation is mostly nullified by our natural defenses. The small amount of glycation that escapes such nullification is responsible for our gradual aging with the passage of time.

We always want to minimize glycation so as to optimize good health and live to a ripe old age. We can do this quiet easily by adopting a healthy diet. Some health professionals say that glycation can be minimized by following a low-carb diet so as to reduce blood glucose. The reasoning is that if blood glucose is reduced there will be fewer glucose molecules to cause glycation.

This is false reasoning because the body is compelled to always maintain a given level of glucose in the blood, regardless of what is eaten or not eaten. In other words, glucose is always present in the blood within a very narrow range (not too much, not too little), otherwise we would die. Without glucose, the brain would shut down, red blood cells would die and so on. So the body is compelled to always have a certain level of glucose in the blood regardless of the type of diet.

Adhering to a low-carb diet does not reduce the default level of blood glucose that we must always have. If we over-eat carbs and sugary foods, blood glucose will go up above the default level temporarily but the body quickly brings the level down in a matter of minutes using insulin for the task. In this scenario, the rise in glucose is too brief for any significant increase in glycation to occur.

If we avoid eating carbs and sugars such as in fasting regimes or a ketogenic diet, the body makes its own glucose by stripping protein from muscles and internal organs (including heart muscle). Then, like an alchemist, the body mixes the stripped protein with other materials found inside the body to produce its own 'home made' glucose (a well-known process called gluconeogenesis).

Note: this is a major reason for never following a ketogenic diet; it weakens your muscles and organs, greatly speeding up the aging process.

If we cannot blame glucose for the ravages of glycation, what can we blame? We can blame a poor diet that increases the number of proteins circulating the blood. The bigger the number of blood proteins, the bigger the chances that some of them will be glycated by the ever presence of glucose.

So the question is: what aspect of a diet causes the biggest rise in blood proteins? In a word: fructose. The regular consumption of fructose increases blood proteins more than anything else you could consume.

There is endless confusion over this subject because fructose is a kind of sugar. Because of this it is mistakenly thought by some people that fructose enters the blood as a sugar to cause glycation. This is not so. Even Wikipedia is wrong to state that "Glycation is the result of the ...bonding of a protein or lipid molecule with a sugar molecule such as fructose or glucose". This is scientifically incorrect and here is why.

When you consume fructose it doesn't go into the bloodstream directly as does glucose; it must first go to the liver where some of it is converted into glycogen. Any excess fructose in the liver is then converted and sent into the bloodstream as lipids (not as a sugar). These fructose lipids are encapsulated inside protein wrappers. It is these protein 'packages' that offer a target for becoming glycated. It is therefore incorrect to think that fructose sugar enters the blood and bonds with lipids to form AGEs.

Remember that the greater the presence of blood proteins, the greater the likelihood that some of those proteins will bump into glucose molecules and bond (i.e. glycate) to form harmful AGEs.

As glycation is a major cause of harmful free radicals, minimizing glycation is a major key to good health and longevity.

Minimizing or avoiding consumption of fructose is easier said than done. All kinds of sugar, syrups, and honey are 50% fructose. And fructose is added to many processed and packaged foods as a sweetener. Yet fructose is your enemy number one in the context of a long and healthy life.

When you eat food, the carbohydrates and sugars in the food mostly convert to glucose in the bloodstream. This is fine and healthy provided you avoid sugary foods and processed carbs (e.g. cookies, waffles, pastries, etc.) as such foods make your blood glucose shoot up and this is bad for health. Stick to non-processed whole foods as much as possible as this trickle-feeds glucose into your blood, without shooting up and triggering an insulin response.

Glucose is non-fattening, natural and mostly gets used up as muscle energy instead of ending up as body fat. But fructose is another story.

Here are the main metabolic differences between fructose and glucose to show how fructose can wreak such havoc with your health, and why it's considerably worse for you than glucose:

1. When you consume fructose, the burden of assimilating that fructose rests mainly on the liver. This overwhelms the liver forcing it to overwork and become vulnerable to liver disease. But with glucose, your liver is not overworked as most glucose can bypass the liver and go straight into the bloodstream.

2. Every cell in your body, including your brain, uses glucose. Therefore, much of it is "burned up" immediately after you consume it. By contrast, fructose is primarily converted into free fatty acids (FFAs), VLDL (the damaging form of cholesterol), and triglycerides (all collectively known as 'lipids'). These lipids are put into the blood stream by the liver (once it has stored enough glycogen) where they become a target for glycation and consequent illness.

3. Fructose Lipids that escape glycation end up as stored body fat or accumulate as fat droplets in your liver and skeletal muscle tissues, causing insulin resistance and nonalcoholic fatty liver disease (NAFLD). Insulin resistance progresses to metabolic syndrome and type II diabetes. This harmful effect caused by fructose is very well studied because of the plague of diabetes throughout the world.

4. Fructose is more fattening than anything else you could consume. Technically this is so because fructose is the most lipophilic carbohydrate. In other words, fructose converts to activated glycerol (g-3-p), which is directly used to turn FFAs into triglycerides. The more g-3-p you have, the more fat you store. Glucose does not do this.

5. When you eat 120 calories of glucose, less than one calorie is stored as fat. But when you eat 120 calories of fructose this results in 40 calories being stored as fat. Fructose is forty times more fattening than glucose. Consuming fructose is like 'consuming body fat' as most of it is converted into fat! Regular sugar is half glucose and half fructose; sugar is fattening because of the fructose, not because of the glucose. "Anyone who still insists that "sugar is sugar" is way behind the times... There are in fact major differences in how your body processes different sugars, and it's important to understand that when you consume fructose, your body packs on pounds at a much higher rate than it does when you consume glucose". Source: Dr. J Mercola, M.D., Avoid Sugar to Help Slow Aging, mercola.com.

6. The metabolism of fructose by your liver creates a long list of waste products and toxins, including a large amount of uric acid, which triggers your "fat switch," causing you to gain more weight. Glucose does not do this, as it suppresses the hunger hormone ghrelin and stimulates leptin, which suppresses your appetite. Fructose has no effect on ghrelin and interferes with your brain's communication with leptin, resulting in overeating. Put simply, fructose makes you hungry, glucose does not.

7. Cholesterol in your body is not harmful and is carried around the bloodstream in LDL and VLDL wrappers for delivering to parts of the body that need cholesterol. But when these wrappers become damaged by free radicals caused by glycation, the wrappers and their cargoes of cholesterol get caught up in arterial plaque. So the cholesterol 'unwittingly' gets caught in plaque as a result of glycation caused by fructose. "The recognition that LDL glycation is at least as important as oxidation in atherogenesis may lead to improvements in our understanding of its mechanism and how to prevent it". Source: Younis N, Glycation as an atherogenic modification of LDL, Curr Opin Lipidol. 2008 Aug; 19(4):378-84.

8. Fructose causes more glycation than anything else you could eat. As already mentioned, glycation is the process by which blood glucose molecules bond with blood proteins to form advanced glycation end products, or AGEs. This process causes a cascade of harmful ROS free radicals throughout the body that can cause inflammation, cancer, aging, many types of serious illness and a shorter lifespan.

Note: some studies of worms have tentatively concluded that the oxidative damage theory of aging in humans is not a black and white scenario. That ROS free radicals may not be a major cause of aging in humans. But such studies are in the minority; the general scientific consensus is that ROS causes DNA damage to body cells and that the greater this damage the greater the chances of serious illness and a shorter lifespan.

9. Macrophages are scavenger cells that are part of our immune defense system, and as such they have special receptors for AGEs, aptly called RAGEs (think: raging inflammation). These RAGEs bind to the AGEs in our body and get rid of them. Unfortunately, this defensive process can also cause its fair share

of damage. Inside your arteries, for example, the scar tissue created from this process is called plaque. So fructose indirectly creates arterial plaque in two ways: by creating scar tissue that promotes plaque and by creating damaged VLDL and LDL particles that get caught up in such plaque.

For these nine reasons and others you really want to limit the consumption of fructose in your life. Minimizing fructose consumption is absolutely a key factor in optimizing your heath and living longer. But what about fruit and fruit juice I hear you ask? Fruit is high in fructose and we are always being told to eat plenty of fruit for good health.

Here is the answer: when you eat fresh whole fruit and chew it well the fructose content is trickle-fed to the liver without overwhelming it. As a result most or all of such fructose is converted and stored in the liver as glycogen. This glycogen is then gradually used up as cellular and muscle energy.

But when you consume fructose that is added to the food you eat (or concentrated in fruit juice) the fructose is said to be 'unbound' or 'free'. It is this unbound fructose that is so harmful because it overwhelms the liver and ends up as a target for glycation in the form of proteins circulating in the bloodstream.

There is a world of difference between the way the human body treats bound and unbound fructose molecules, i.e. the way it treats the fructose in whole fruit and the way it treats the free fructose in fruit juice and processed foods. A regular modest consumption of fresh whole fruit (chewed well) is excellent and indeed essential for good health.

Metabolically, consuming unbound fructose is very similar to consuming alcohol. The byproducts are similar, which is why the effects on the liver are similar. “It is my belief that fructose is the largest dietary factor behind the rising rates of fatty liver disease among today's youth.” Source: Dr. Joseph Mercola, MD, Fructose is the Leading Dietary Culprit in Childhood Obesity, mercola.com, August 2011.

Although fructose is found naturally in all fruit (and many vegetables), eating small amounts of whole fruit does NOT provide concentrated amounts of harmful unbound fructose that overwhelm the liver. When the fruit is consumed intact and whole, its fiber will somewhat moderate (control) the release of fructose into your bloodstream, as well as somewhat moderate insulin release. Furthermore, the act of chewing the fruit in the mouth allows the fructose to be released into the body much more slowly than gulping it down as juice.

The importance of chewing fruit properly cannot be overemphasized. You should always eat slowly, taking extra time to masticate the food well with every mouthful. This gives enzymes in your mouth time to do their job and greatly improves digestion. Also it gives the body more time to say ‘I am satiated, stop eating, enough is enough!’ If you eat quickly you will overeat before any feelings of satiation become apparent, thus leading to greater stored body fat. "Human saliva is composed of 98% water, while the other 2% consists of other compounds... and various enzymes. Enzymes break down large molecules (starch or proteins, respectively) into smaller ones, so they can be absorbed by the intestines. Mastication is the process by which food is crushed by teeth. It is the first step of digestion...and allows a more efficient breakdown by enzymes. During mastication...the enzymes in saliva begin to break down carbohydrates [e.g. the sugars in fruit] in the food" (source: Wikipedia).

Humans have evolved over millions of years on a diet of raw nuts, seeds, berries, grubs, roots, flowers, tender leaves, herbs, birds eggs, insects, and from occasional meat and seafood. Humans were never

predominantly fruitarians. This is why the human body cannot digest fructose safely unless consumed in moderation and in the form of whole fruit that is chewed well.

When you drink fruit juice, even if you only sip it slowly, you don't get the benefit of allowing the enzymes in your mouth to do their job to aid digestion, and you don't get the satiation message that says "enough is enough". Worse still, if you drink fruit juice during a meal you will store a greater amount of fat from the meal than otherwise. This happens because the fructose interacts with the molecules of the food being consumed and a greater proportion of the glucose derived from the food ends up as surplus body fat. Avoid drinking fruit juice, particularly with a meal!

Fruit juice contains little to no fiber – but most kinds of sweet-tasting fruit juice typically contain about eight full teaspoons of fructose sugar per eight-ounce glass (just think of it: about one full teaspoon of fructose sugar per fluid ounce!). This fructose is brought rapidly into your body, promoting obesity, glycation and other health problems. Drinking a glass a freshly squeezed orange juice for example, even if diluted with a little water, may give you some nutrients, but is super-bad for health because of the concentrated fructose.

Dr. Robert Lustig, Professor of Pediatrics in the Division of Endocrinology at the University of California in San Francisco, is a distinguished authority on fructose. He says:

"fructose is poison, out and out, and it is every bit a poison in excessive quantities as is alcohol. It's metabolized exactly the same way, and it's what's giving even children fatty liver disease, a precursor to cirrhosis."

Dr. Lustig raises an interesting aspect about the myth of obesity being "no more complicated than a lack of activity combined with excessive caloric intake." If that's true he asks, then how is it that he sees so many obese 6-month old infants in his practice? Is a 6-month baby lacking in exercise? No it's not – infants become obese because they are given baby foods high in fructose, not because they lack physical activity.

To summarize, here briefly is the difference between consuming whole fruit and consuming fruit juice (or products with added fructose):

Whole fruit

When we eat whole fruit, the sucrose (sugar) is broken down to fructose and glucose slowly and calmly inside the body. This happens for two reasons:

1. As the fruit is chewed well, the sucrose in the fruit combines with enzymes in the mouth. This starts the process of good digestion.

2. The sucrose is composed of glucose and fructose bound together. As such it is digested slowly and calmly in the upper small intestine until it is broken down to unbound glucose and fructose and sent to the liver.

As this is going on, any small amounts of unbound glucose and fructose that was always in the fruit will go directly to the liver. But this will not be enough to overwhelm the liver (assuming that only a modest amount of fruit was consumed and chewed well). Hence the glucose and fructose from the whole fruit will end up as healthy glycogen stored in the liver.

Fruit juice and unbound fructose

When fruit juice (or products containing added fructose) are consumed, the high concentration of unbound fructose will bypass the digestion process and go straight to the liver. Any high amounts of glucose that may also be in the food will pass into the bloodstream and cause a temporary excess of glucose in the blood. This in turn will create an insulin spike so as to bring down the level of glucose to a default level. Over time, this constant demand for insulin can weaken the body's capacity to produce insulin, leading to insulin resistance and diabetes.

The unbound fructose in the fruit juice (or product containing added fructose) will most likely overwhelm the liver, leading to an over-production of lipids in the blood, harmful glycation, rampant free radicals, serious illness, obesity, pre-mature aging and a shorter life.

Regarding fructose digestion, for those who want the science verbatim, here it is: Upon gastric absorption both fructose and glucose are delivered via the portal vein to the liver. It is believed that the ability of the liver to metabolize high doses of fructose is responsible for the disruption in energy stores and fuel metabolism observed. In the liver, fructose is metabolized into glyceraldehyde and dihydroxyacetone phosphate. These particular fructose end products can then readily converge with the glycolytic pathway. Of key importance is the ability of fructose to by-pass the main regulatory step of glycolysis, the conversion of glucose-6-phosphate to fructose 1,6-bisphosphate, controlled by phosphofructokinase. Thus, while glucose metabolism is negatively regulated by phosphofructokinase, fructose can continuously enter the glycolytic pathway. Therefore, fructose can uncontrollably produce glucose, glycogen, lactate, and pyruvate, providing both the glycerol and acyl portions of acyl-glycerol

molecules. These particular substrates, and the resultant excess energy flux due to unregulated fructose metabolism, will promote the over-production of triglycerides.

According to Gary Taubes, a nutritional author, "The fructose is mostly, about 90-95 percent metabolized in your liver. The pathway by which it's metabolized is fundamentally different. The place at which it's metabolized is different to that of glucose. It makes the liver do more work than just assimilating say a starchy food."

Diet apart, glycation can also be caused to a lesser extent by poor lifestyle factors such as smoking, alcohol abuse and drugs, as these factors affect the bloodstream.

"Certain components of mainstream cigarette smoke can react with [blood proteins] to form covalent adducts with many of the properties of advanced glycation end products

(AGEs)". Source: Nicholl ID, et al, Advanced glycation end products and cigarette smoking Cell Mol Biol (Noisy-le-grand). 1998 Nov; 44(7):1025-33.

"AGEs fluorescence [the severity of AGEs] was significantly higher in chronic alcoholic patients than in healthy subjects". Source: Kalousová M, et al, Advanced glycation end products in patients with chronic alcohol misuse, Alcohol, 2004 Jul-Aug; 39(4):316-20.

To an extent, glycation is a fact of life. It's happening right now, to all of us. It can even be measured: The cross-links formed between sugars and proteins emit a fluorescence, which scientists can capture using Visia complexion-analysis cameras. "If you take a fluorescent image of children, their faces will come out very dark," says Procter & Gamble biochemist Greg Hillebrand, PhD, "but with each decade, the AGEs, and therefore the brightness, will accumulate more and more."

This means that by the time we reach our dotage, we can expect our fluorescent images to resemble those of the incandescent aliens in Cocoon! The external signs of glycation show up around the age of 30 or 35, when a perfect storm of built-up sun damage, environmental oxidative stress, hormonal changes, and the development of AGEs begins to result in, well, a-g-e. "When you're younger, your body has more resources to ward off damage, and you're producing more collagen," says dermatologist Fredric Brandt, MD. "When you reach a certain age, these sugar by-products [AGEs] begin to build up at the same time that your threshold for damage is getting lower."

Summary: Avoid glycation by minimizing or avoiding fructose consumption and by avoiding harmful lifestyle factors such as smoking and alcohol that also promote glycation.

Resource: Science of Longevity by Russell Eaton

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