**Week 3: Various food related claims**

This week, we will very briefly explore various food related claims. As usual, if you believe that I am wrong on something, discuss it (email or we can via email set up a time to ‘Zoom’ discuss) and be prepared to bring your evidence.

First, some background: (very) basic concepts of toxicology.

Toxicology is the study of toxic substances and poisons. Note that the difference between a toxic substance and a poison is that toxic substances are made by nature and poisons are made by humans. In terms of the physical/chemical/biological effects on living systems, there is NOT a difference between toxins and poisons.

The ‘First Law’ of Toxicology: ‘the dose makes the poison’. EVERYTHING is NOT toxic in sufficiently low amounts and IS toxic in sufficiently high amounts. To state this another way: while water is a required substance, if you drink too much water too fast (particularly de-ionized water), you die. If this sounds like nonsense to you, search the terms ‘water intoxication’ or ‘hyponateremia’.

The fact that a huge amount of a substance may be harmful DOES NOT infer that a small amount of that substance is harmful. Our bodies have ways of ridding themselves of toxic substances – if the toxic substance dissolves in water, our kidneys will filter it out of our blood and into our urine or our skin will sweat it out of our body. Our livers have the task of detoxifying substances – chemically reacting with a substance in order to turn it into a nontoxic substance or one that is water soluble so that our body can get rid of it. This doesn’t mean that all toxic substances are neutralized and/or disposed of, it means that we have more chemical ‘cleanup’ systems than people realize.

When a potentially toxic substance is discovered in food, studies are performed to determine the toxicity of the substance and, the exposure amount – usually expressed in terms of weight of the substance per human body weight per day – as an example ‘milligrams (of the substance) per kg (of human body weight) per day that the scientific evidence shows is unlikely to have an adverse effect on the body. We can think of this as a ‘safe exposure limit’.

**Endocrine disruptors** are substances that could ‘bind’ or have been shown to ‘bind’ to hormones. Binding describes two molecules that ‘stick’ to each other after colliding together. Binding can be ‘strong’ or ‘weak’. Strong binding occurs when the two molecules stay stuck to each other for a significant amount of time; in weak binding, they quickly come apart.

The ‘endocrine disruptors’ that have generated the highest amount of attention are BPA (BisPhenol A) and phthalates. BPA is one of the reactants (ingredients) that are used to form thin ‘plastic’ films that coat cans. Cans are made of metals (steel) and if they are NOT coated, the food substance in the can will eventually corrode (dissolve, eat through) the can. Acidic foods such as tomatoes are particularly aggressive towards cans. So, the can must be coated with a substance that the tomatoes (or other food) cannot dissolve.

While PBA is NOT the coating, BPA is used to make the coating. Very small ‘trace’ amounts of unreacted BPA are left in the coating and can become dissolved into the food.

BPA is a VERY weak hormone binder and is very quickly converted by the human body to a substance (‘metabolite’) that is quickly excreted in urine.

There has been a considerable amount of research regarding BPA in foods. This research has determined that BPA is NOT a significant problem. Until new evidence that shows that BPA IS problematic (and not the old evidence that gets continually recycled), the best evidence shows that BPA is NOT a problem.

Suggestion: ignore BPA claims unless there is new, compelling evidence.

**Phthalates** are a type of chemical added to ‘hard’ plastics – particularly PolyVinylChloride (PVC). Note that plastic water pipes (very hard and brittle), plastic intravenous (IV) bags – those used to hold fluids that are injected into patients (soft and supple) and car dashboards are all made from PVC. IV bags and dashboards contain plasticizers; the plastic water pipes do not. Plasticizers are also what gives new cars their ‘new car smell’.

As with BPA, small amounts of plasticizers can ‘leach out’ of plastics and into foods and drinks. We should note that the chemical structure of phthalates and other plasticizers make them ‘insoluble’ which means that there is a very, very, very small amount of it that can dissolve in water. Still, tiny amounts of plasticizers, such as phthalates can be found in food and solutions.

As with BPA, plasticizers/phthalates have been extensive studied and it has been determined that the exposure amount is much less than the problematic level.

Suggestion: ignore these claims unless there is new, compelling evidence.

Phytoestrogens are naturally occurring chemicals that are in some foods; most notably soybean products. These are unlikely to be problematic. These can be avoided by not eating tofu, edamame and other soybean based foods. These are unlikely to be problematic.

**Food from Genetically Modified Organisms (GMOs)/ Genetically Engineered Organisms**

This one is a bit complicated; some science is needed to put this into context.

DNA – how the ‘genetic code’ is stored in cells. DNA is a ‘chain’ with four different ‘links’ (nucleotides/’nitrogenous bases’). The ‘code’ is how these four different nucleotides are arranged in the chain. DNA tells cells what proteins to make.

Proteins are what gives an individual it’s particular properties. In regards to humans, each of the physical properties – hair color and type, eye color, skin color, whether you are short or are tall, whether or not you have the physical properties to excel as an athlete – are all determined by proteins, which are determined by the DNA that came from the parents + the mutations that are unique to that individual.

So, DNA determines proteins and proteins determine properties.

Humans have been changing the DNA/proteins/properties of plants and animals for 1000’s of years via selective breeding – deliberately breeding individuals with specific properties together in hopes of developing offspring with those properties. The problem with selective breeding is that it is very much ‘hit or miss’; the offspring may have the desired properties and may have very much unwanted properties.

In the late 1960’s and early 1970’s, scientists from Pennsylvania State University and the US Department of Agriculture, working with the Wise potato chip company, developed the Lenape potato specifically to use for making potato chips. The Lenape made a ‘damn fine potato chip’. It was also toxic as it made excessive amounts (relative to other potatoes) of the toxic substance solanine.

While conventional selective breeding is still performed today, another way of changing DNA is via ‘gene editing’ (‘CRISPER’ technology). We can selectively gene edit DNA to remove the DNA that codes for a protein that we don’t want and to selectively add DNA for a protein that we don’t want.

Artic apples are genetically engineered by removing the DNA for the protein that turns the apple flesh brown after the apple has been cut. Most people don’t find brown apples appetizing, yet the browning naturally occurs and doesn’t degrade the nutrients in the apple. Artic apples do not turn brown after they have been cut – the goal was to be able to sell sliced apples that look appetizing and do not need preservatives.

Rainbow papaya is a example of a genetically engineered product in which DNA for a protein was added. Rainbow papaya is grown in Hawaii; a naturally produced pathogen devastated Hawaiian papaya trees. The protein that is produced by the DNA modification in rainbow papaya trees give these trees natural immunity to the pathogen that destroyed the non genetically modified trees.

Aquaadvantage salmon are farm raised salmon that grow to processing size in 18 months instead of the thirty six months that are required for conventional salmon. Aquadvantage salmon have had DNA for specific proteins that result in more efficient feeding and thus the faster growth.

Some GMO claims and realities:

Claim: GMOs have not been studied.

Reality: GMOs have been studied and arguments regarding their use since 1980. The claim is demonstrably false.

Claim: GMOs are unregulated.

Reality: A food item from a GMO plant or animal must be approved by the US government – likely the Food and Drug Administration – before the item can be sold. The approval process for AquaAdvantage salmon literally took 20 years.

Claim: GMOs cause cancer.

Reality: No evidence for this. This claim is biologically implausible. Remember that genetic modifications can either be removing DNA which prevents a protein from being formed or adding DNA that results in a protein being formed.

Removing the DNA and the protein CANNNOT cause harm to the consumer. Not possible. Not plausible. The absence of either the DNA (gene) or the protein cannot be harmful to the person eating the plant material.

Adding DNA/a protein: the added DNA cannot be harmful. DNA is immediately broken into its constituent nucleotides (the ‘chain’ gets broken into its ‘chain lengths’) by digestion. Claims that the DNA can interact with normal human DNA are speculative, implausible and are not supported by evidence.

The added protein COULD be harmful, but ONLY if it triggers an adverse (such as allergic) response in the consumer. There are allergic foods – peanuts being one of the more common ones. However, most proteins are efficiently broken down by the body to their amino acids (the protein chain broken into its individual links) – only proteins that resist digestion typically are allergenic. So, it is possible that a ‘non-native’ protein from the added gene could trigger an allergic response. Highly unlikely and this is one of the reasons for the extensive testing. Companies are smart enough to realize that they lose money when their products harm their customers.

The take home message: the exaggerated claims of GMO opponents are highly unlikely to be true and have largely been refuted.

If you would rather avoid GMO products, it is unlikely that you will ever be forced to consume them. On the other hand, there is no logical reason to spend money on ‘luxury beliefs’ such as anti-GMOs.

**Gluten** is a naturally produced (non GMO!) protein in wheat, barely and rye. Some people have adverse reactions when they consume food that contains gluten. Celiac disease is an allergic response to gluten. Celiac disease tends to run in families (<https://www.mayoclinic.org/diseases-conditions/celiac-disease/symptoms-causes/syc-20352220>). It is estimated that between 0.7 and 1.4% of all humans have Celiac disease (<https://celiac.org/about-the-foundation/featured-news/2018/08/global-prevalence-of-celiac-disease/>).

There is a controversy regarding whether non-Celiac ‘gluten sensitivity’ is or is not a real disease. The problem is that the symptoms of ‘gluten sensitivity’ tend to be highly subjective and many people have self-diagnosed themselves from ‘Dr Google’ and from random internet ~~idiots~~ influencers. It is estimated that 6% of US population may have non-Celiac gluten sensitivity (source: Cleveland clinic).

The take home message: if you have been diagnosed by a real physician (note: not a ‘naturopath’) with Celiac or non-Celiac gluten sensitivity, then you need to avoid products that contain wheat, barley and rye. No breads, cookies, cakes or pizza crusts. This is doable but does present a problem in social situations and meals eaten from home.

If you haven’t been diagnosed with Celiac or non-Celiac gluten sensitivity, the odds are that you DO NOT have it, as both are rare. Very likely that there are more people who believe that they are gluten sensitive than who actually are.

**Conventional and Organic plant production**

Conventional: uses ‘chemical’ fertilizers and pesticides. Fertilizers add ‘plant nutrients’ – particularly bioavailable nitrogen (ammonia, ammonium, nitrate) to soil. Pesticides include herbicides (used to kill unwanted plants – ‘weeds’), insecticides (used to kill/repeal insects) and fungicides (used to stop/prevent molds).

There is a false claim that ‘organic doesn’t use fertilizers or pesticides’. This claim is true only if the organic producer does NOT use approved fertilizers or pesticides. To state this differently, there are ‘organic’ fertilizers and pesticides that are approved for ‘organic’ use.

Crops often deplete soil nutrients which periodically need to be added back to the soil. Biomass in the form of compost or manure is an organic fertilizer.

BT (a bacterium that is toxic to insects) is a pesticide that is approved for organic food production. Copper sulfate is a fungicide that is approved for organic food production (<http://npic.orst.edu/ingred/organic.html>).

Claim: Organic plant production is ‘more environmentally friendly’ than is conventional.

Response: this is not an objectively testable claim as how would one objectively test it? What is known that organic food production produces less food per area (per acre) per year than does conventional. Thus, the higher the amount of organic production, the higher the amount of agricultural land required for the organic production.

Regarding pesticide residues on conventionally produced foods, according to the US Department of Agriculture (<https://www.usda.gov/sites/default/files/documents/OPMP-Pesticide-Tolerances-Factsheet.pdf>), 99% of food products sampled in 2019 had residues below tolerance (this means below the allowable amount) and 42.5% did not have detectable amounts of pesticides.

As with all potentially harmful substances that may be found in food products, the tolerable /permissible amount is much lower (typically 1000 times lower) than is the amount that is expected to produce a harmful effect.

Claim: organic produce (fruits and vegetables) have higher amounts of nutrients than do conventional.

When ‘blind’ samples are sent to labs (‘blind’ meaning that the testing laboratory does not know if the sample is conventional or organic), no significant difference in the nutrient levels can be found between conventional and organic.

We can conclude that ‘honest’ testing shows that this higher nutrient level claim is false.

The ‘bottom line’ – There isn’t any real evidence-based reasons to purchase organic products, but if you want the organic stuff, then purchase the organic stuff. Unfortunately, produce prices have increased during the past two years. As we will see, the higher the amount of fresh fruits and vegetables that a person consumes, the likely better their health will be. Likely all of us have constrained spending ability.

If a person has, say $20 per week to spend on produce, it is much better for their health to consume more of the less expensive conventionally grown produce than less of the more expensive organically grown produce.

**Assignment:**

This week, we discussed the claims of Endocrine disrupters, GMOs and Organic produce.

Find a source that argues that the endocrine disrupters are a problem (search term: ‘endocrine disrupters). Give their argument and more importantly, give the EVIDENCE that they claim for their argument. Analyze their evidence. Look for ‘weasel words’ such as ‘could, might, may’, etc.).

Repeat this for anti-GMOs and for Organic instead of conventional produce.

Discuss: Are any of these strong claims that are backed by strong evidence?

As always, if you think that my claims are wrong, bring your evidence and let’s discuss it.