GMOs in Healthcare

An overview

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in collaboration with
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People take supplements for a variety of reasons; to maintain health and vitality, to correct nutritional deficiencies, to support specific physiological functions or just as a kind of 'health insurance' policy.

For many, taking quality supplements is a priority. Increasingly, 'clean labels' which use simple ingredient names, and claim minimal use of colours, preservatives and fillers, the inclusion of natural and food source ingredients, being free from genetically modified organisms (GMOs), gluten and allergens – are being used to guide supplement choices.

If you are someone who thinks that the inclusion of GMOs is incompatible with a health supplement you may be surprised to know that genetic engineering is quietly, but increasingly, being used to produce both health supplements and pharmaceutical drugs.

Over 100 genetically engineered drugs are currently on the market including human-identical insulin and growth hormones, artificial skins, anticoagulants, vaccines and even rattlesnake anti-venom.

Many of the same companies that make pharmaceutical drugs also make health supplements or have sub-divisions that make specific ingredients. Technologies like new genetic engineering processes can be applied equally across all parts of the business.

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People taking these often life-saving drugs can be very ill and probably don't know – and may not even care – if they are genetically engineered. But those who take supplements for health maintenance, who may otherwise consciously try to avoid eating GMO foods, may take a different view.

Where do GMO ingredients come from?

For many years the use of GMOs in health supplements was limited to starting materials such as maize or soya. Fillers and other additives such as citric acid, corn starch, maltodextrin, soya lecithin and xanthan gum can easily and cheaply be extracted from genetically engineered plants for use in supplements and foods.

But now a new type of genetic engineering, known as synthetic biology, or 'synbio', is being used to produce supplement ingredients.

With synthetic biology, microorganisms such as yeasts and bacteria, are re-engineered to become living factories for producing a variety of substances. These genetically engineered organisms can be made to produce greater quantities of substances they might naturally produce, or to produce substances that they would not naturally produce.

There are now several synbio supplement ingredients on the market already, including astaxanthin, resveratrol and omega-3 fatty acids which are produced using this method (see box page 3) – and more are on the way.

How are GMO supplements regulated?

GMO food sources for supplements don't need to be declared on the label because these foods have already been classified GRAS (generally recognised as safe) by food regulators. GRAS status for GMOs is based on a concept called 'substantial equivalence'.

In food safety, genetically engineered foods, which look and taste the same, and which may have the same basic nutrients in them as conventionally grown foods, are considered to be 'substantially' the same as non-GMO foods and ingredients.

But substantial equivalence has been proven to be a faulty concept. A genetically engineered ear of corn may look and taste the same as a conventionally bred corn. But scientific studies have shown that at the genetic level the two are very different.

For example, GMO maize variety NK603, widely consumed by humans and animals around the world, has been shown to be substantially different from non-GMO maize. Recent rsearch has shown that 117 proteins and 91 metabolites are significantly altered by the genetic engineering process.

The GMO maize also had levels of the polyamines cadaverine and putrescine, that were 2-3 times higher than in non-GMO corn. These polyamines can heighten allergic reactions and are involved in the formation of carcinogenic substances in the body.

Many studies are now showing multiple differences between conventional and GMO plants. It is possible that, in part, this is what is driving the trend for more food ingredients produced via synthetic biology which, it is claimed, can produce 'pure' ingredients in large bioreactors, and bypass the complications of working with plants.

What are the concerns over GMO supplements?

Synbio ingredients are relatively new and have also been ushered onto the market under cover of GRAS and substantial equivalence.

Apart from inadequate regulation, there are clear issues of lack of transparency which manufacturers and regulators are simply not addressing. For instance, these ingredients are being used in products that are labelled 'natural' and yet, clearly, genetically engineering a microorganism by inserting a foreign gene into it or switching on or off certain genetic functions is not natural.

The process by which these microorganisms produce different substances, when it is described in the media at all, is referred to as 'fermentation'. But it does not involve fermentation as most people understand the term. It is not, for instance the same natural process that produces sauerkraut, kimchi, kefir or even beer.

Fermentation, in this instance, describes a process whereby genetically engineered organisms, are placed in large temperature- and light- controlled tanks. They are fed on a diet of sugar and nutrients and then secrete the desired substances, which are then strained off, purified and processed further for use in supplements.

The process is often promoted as being more environmentally friendly than growing plants, but in reality it is energy intensive, especially when producing at scale, and feed stocks like sugar still have to come from conventional – usually GMO – farming.

Health impacts

Making genetically engineered supplements cheaply and in bulk, according manufacturers, will mean more people can afford them and benefit from their health-giving properties. But there is no sign that the genetically engineered supplements currently on the market are better value. Indeed many use their high-tech status to command higher prices.

These prices might be considered worth it if there was proof from large-scale human trials that they were more affective. But these trials are not taking place because they are not required by regulators.

When testing is done, it is usually small scale, often involving only dozens of people, over short periods of time. This means that neither efficacy nor safety can be conclusively proven.

Historically, there have been serious problems with some genetically engineered microorganisms. In the 1990s a food supplement, tryptophan, produced by the fermentation of GM bacteria, was responsible for killing hundreds of people and left thousands more with a debilitating neurological disease called eosinophilia-myalgia syndrome (EMS).

Regulators went to great lengths to deny any link with the GM bacteria, but eventually it was shown that the GM bacteria used to produce the tryptophan, was producing the potent mutagen,

Supplements most likely to be GMO

GMOs can enter the supplements we take by one of two main routes: nutrients can be extracted from genetically engineered plants or they can be manufactured by genetically engineered microorganisms

Anthocyanins can be synthesised from a combination of different strains of genetically engineered bacteria.

Astaxanthin can be synthesised from genetically engineered algae.

Beta carotene can by produced from genetically engineered spirulina.

L-Alanyl-L-Glutamine is synthesised by a genetically engineered *Escherichia coli* (*E. coli*) strain. This amino acid is often found in sports drinks.

L-cysteine this amino acid, often added to supplements and infant formulas, can be derived from genetically engineered *E. coli*.

L-phenylalanine this amino acid can be synthesised from genetically engineered *E. coli*.

Nicotinamide riboside (NR) is a member of the B3 family. Supplements on the market are synthesised from genetically engineered yeast, for example, *Saccharomyces cerevisiae*. Look for brand names like TruNIAGEN.

Resveratrol can be derived from a genetically engineered yeast. Look for brand names like Veri-te™ or EveResveratrol.

Spirulina comes from algae, e.g. *Arthrospira cyanobacteria*, engineered to double its yield of the antioxidant phycocyanin.

Vitamin D2 can be derived from a yeast e.g. *Yarrowia lipolytica*, genetically engineered to produce ergocalciferol.

Vitamin E Many 'natural' vitamin E in supplements are sourced from GMO soya.

methylglyoxal, which was making people sick.

Most recently, a type of vitamin B2, made from genetically engineered bacteria and approved for use in animal feed, was determined to be spreading antibiotic resistance amongst farm animals.

Manufacturers claimed that all the antibiotic-resistant bacteria was stripped from the supplement before it was sold, but tests showed the live bacteria remained in the supplement and was being passed on to animals via their feed.

The future of medicine?

Manufacturers see genetically engineered medicines and health supplements as a growth market. So, in addition to using genetically engineered microorganisms, researchers are currently experimenting with turning other living organisms into drug factories.

Biotech companies are genetically engineering plants to produce 'edible vaccines'. The first test subjects for these will likely be people living in some of the poorest regions of the world where, coincidentally, there are also fewer restrictions on such trials.

Worldwide, there are ongoing experiments with genetically engineered animals – some of which are being designed as living, breathing bioreactors for producing drugs at industrial scale in their milk, eggs, blood and urine. The first commercial drug produced in this way, ATryn, was approved in 2009 and is an antithrombotic derived from the milk of genetically engineered goats.

In 2014, the US Food and Drug Administration (FDA) approved Ruconest, a drug collected from the milk of genetically engineered rabbits and used to treat hereditary angioedema.

In 2015 the FDA approved a genetically modified chicken that makes a drug called Kanuma, used to treat lysosomal acid lipase deficiency – a rare genetic condition that prevents the body from breaking down fatty molecules inside cells.

Genetically modifying humans via gene therapy is also emerging as a treatment option for diseases ranging from rare metabolic disorders to cancer.

It's too early to tell whether any or all of these options are better or worse than conventional treatment options – and comparative studies are rare.

More to come

Very soon we are likely to see synthetic biology being used to create a variety of health maintenance products including polyunsaturated oils, probiotics and prebiotic oligosaccharides and even more antioxidants compounds

These 'healthy' ingredients are intended for use in supplements, health foods and liquid meal replacements (including for those used in hospitals) and in emergency foods for famine relief. Synbio analogues of human milk are also being devised to replace current infant formulas.

Some large corporations are investing in synbio 'good bacteria' that can be implanted into the gut. Like the edible vaccines, the experimental subjects for these bacteria are often those – and in particular children – in developing countries where malnutrition and disease are rife.

Experiments with genetically engineered probiotics are particularly concerning because these new types of organisms have never existed in the human gut before.

Consumers can ensure the quality of their supplements by choosing products that are certified non-GMO or organic – or better yet, both

Intestinal flora is complex and the populations of different microorganisms in our guts are dynamic in the way they respond to our diets and to environmental pressures. Lack of long-term testing means we have no idea what placing a few genetically engineered strains into the mix will do – for good or for ill.

Making choices

Good health is a priceless resource. Getting the bulk of your nutrients from a wholesome diet is a must. When this is not possible, for whatever reason, we should be able to rely on quality supplements.

Consumers can ensure this quality by choosing products that are certified non-GMO or organic – or better yet, both – since the the hidden nature of GMO processing aids presents increasing challenges for organic certifiers.

It's also important to push for greater regulatory oversight and mandatory surveillance of any products on the market.

There is also a need to keep pressuring supplement brands to do their due diligence, find out where their ingredients come from, and to indicate this clearly on the label and online. This ensures that those who want it have a free choice of whether or not to consume GMO supplements.