

Nano-Nano: What Would Mork Say?

It seems just yesterday that "nano-nano" (actually it was "nanu-nanu") was a humorous alien greeting. But today, we are inundated with the news and the promises of all the up-and-coming nanotechnologies. As some of these new nanotechnologies are just now beginning to be included in nutraceutical supplementation, it behooves us as natural health providers to become at least a bit more informed.

So, what is nanotechnology? What is its purpose in supplementation? Is it safe? Is it efficacious? Let's answer those questions.

What Is Nanotechnology?

Nanotechnology is the development of methods for fabrication, synthesis and characterization of materials at the nanometer scale.¹ A nanometer is one-billionth of a meter, one-millionth of a millimeter, and one-thousandth of a micron! Therefore, it is typically accepted that nanotechnology involves the manufacture and manipulation of molecules from 0.1 nanometers to as large as 200 nanometers in size!

There are two fundamentally different approaches to nanotechnology: *incremental* and *evolutionary*. Incremental means simply to make substances very small. Evolutionary nanotechnology is a more advanced, challenging and promising technology. It endeavors to create or assemble nanostructures that do actual work.²

As they pertain to supplements, and for that matter, pharmaceuticals and cosmeceuticals, incrementally nanosized substances increase surface area, facilitate solubility, and enhance bioavailability simply because of their extremely small size.

At present, supplement delivery systems that use evolutionary nanotechnology involve the creation of nanosized vesicles that infuse or encapsulate nutraceuticals. Besides being small in size, the outer shell of the nanovesicle may be more bioavailable than the nutrient or nutraceutical inside the vesicle, and may provide a *protective function* as well.

Currently, these evolutionary nanovesicles are created for use in nutraceuticals using organic molecules such as lipids and/or carbohydrates. I am not yet familiar with peptide-based nanovesicles in the nutraceutical field.

What Is the Purpose of Nanotechnology in Supplementation?

As nanotechnology pertains to nutritional supplements, many of you are familiar with the use of an "old" technology that would now be defined as a nanotechnology. That technology uses phosphatidyl choline (PC) and other essential phospholipids to create liposomes: submicron-sized lipid vesicles. Indeed, liposomes ranging from 50nm to 500nm in size are naturally formed by the body when meals containing fats are consumed.³

PC liposomes were developed commercially in the 1970s and have been used since in pharmaceuticals, cosmeceuticals and, a decade or two later, in some nutraceuticals.⁴ Liposomes are used to protect the potency and efficacy of oral nutraceuticals by:

1. providing lipid nano-encapsulation, protecting them from untoward degradation from moisture and oxygen;
2. protecting them from undesired enzymatic activity from the mouth or gut, especially in the case of delicate nutraceutical peptides;
3. protecting them from the undesired effects of bile salts and commensal micro-organisms;
4. protecting them from food and drug interactions;
5. enhancing bioavailability, especially of poorly bioavailable substances like vitamin B₁₂, or phytonutrients like vitamin K, CoQ₁₀, and many flavonoids; and
6. making fat-soluble nutrients, phytonutrients and phytochemicals much more bioavailable even when taken without fat-containing meals, as with just cold water or juice.

In the early 1990s, some new kinds of liposomes were created and patented.⁵ These combined phospholipids with certain organic molecules called glycols (sugar alcohols) in varying ways to produce a new lipid-based, evolutionary nanotechnology. The advantages were:

1. They infused nutraceuticals into liposomes "spontaneously" with a simple "pour-and-mix" technology. This avoided the use of pressure, sonication and micro-filtration, thus greatly lowering costs while simultaneously minimizing degradation that may attend such intense physical processes.
2. They carried a water shield, making them "stealthy," meaning that they could avoid ingestion by macrophages, a potential undesirable problem with regular PC liposomes.
3. They have the potential to be tagged and therefore be delivered to particular target sites, even into the mitochondria.⁶

Does It Work?

Certainly the logic and science behind both incremental and evolutionary nanotechnology, as they pertain to nutrient and phytochemical supplementation, are sound. This is particularly true with liposomal technologies which mimic nature's own strategy for digesting fats via the formation of liposomes in the gut. Whether a particular nanotechnology works for a particular supplement or product is a different question.

Certainly at a minimum, companies should provide both *in-vitro* and *in-vivo* analysis backing up their claims. As nanotechnology involves products no larger than 200nm, *in-vitro* analysis would best consist of electron microscopy, demonstrating both nano size and stability. In the case of nanosomes, demonstrating infusion or encapsulation, meaning proof that the nutraceutical is inside the nanosome, is needed.⁷ *In-vivo* analysis should be presented to demonstrate bioavailability, either through electron microscopy or

measurement of biomarkers related to the supposed effects of the nutraceutical in question, such as plasma antioxidant capacity.

Is It Safe?

Much to my chagrin, I was told by a chiropractor who attends postgraduate seminars at his alma mater that a doctor teaching nutrition taught him "to never use supplements with nanotechnology." Though there is indeed reason for caution with any "new-fangled" technology applied to products made for human consumption, many nanotechnologies already have provided toxicology studies and have been in use for 10 or 15 years without incidence.^{8,9} Such evidence can and should be readily provided by, or posted on the Web sites of, companies using nanotechnology to enhance the efficaciousness of the nutritional supplements and/or functional foods they provide.

Conclusion

So, what would Mork say? Well, probably something very funny. Being from a very advanced civilization, he would nonetheless likely be nonplussed, having come from a planet that long ago enjoyed the many benefits of nanotechnology. But if you see Robin Williams before I do, would you ask him for me, please?

Nano-nano!

References

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