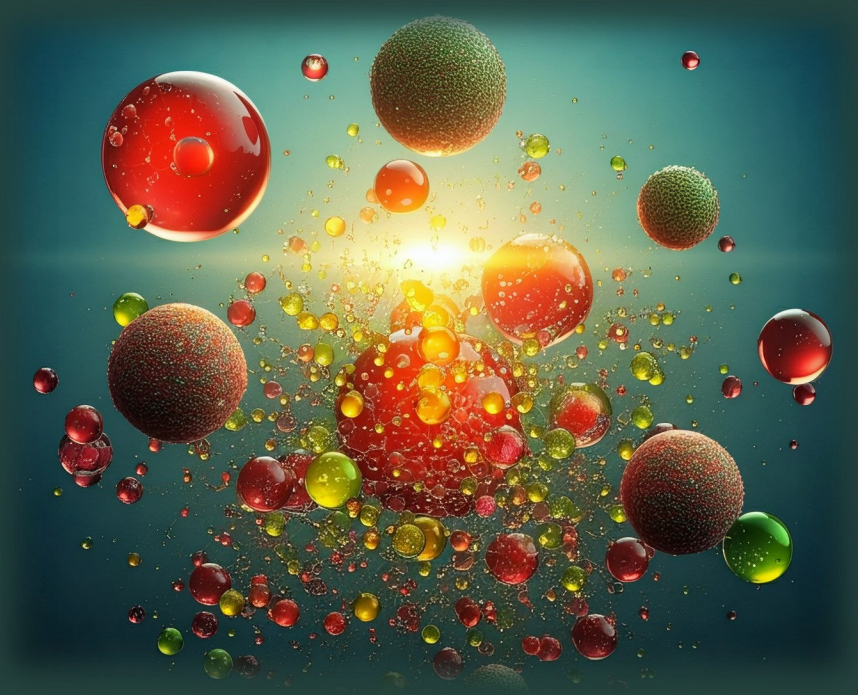
Realities of Liposomes and Nanodispersions in the Food & Supplement Market



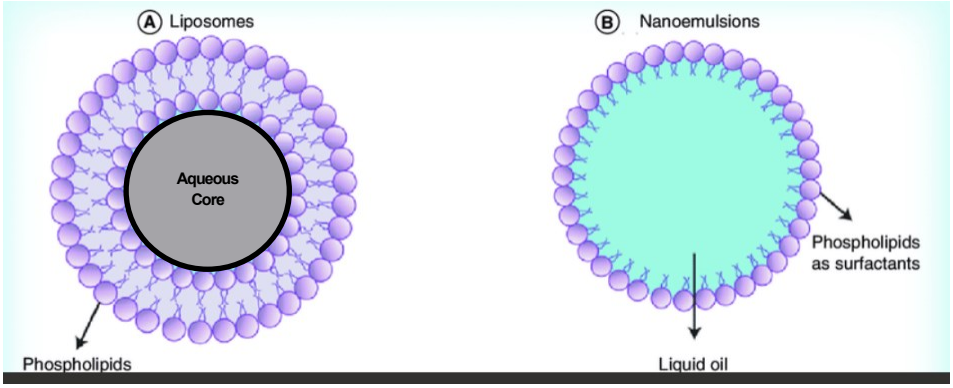
Are you really getting the benefit and technology you were promised?

By: Scott Peters

In the supplement and fortified food market, there is a “buzz” surrounding the use of delivery formats to increase absorption of nutrients and efficacy. Several liposome and nanoemulsion companies advertise that their products do just that. In addition, several thousand papers, in peer-reviewed journals, support that these technologies truly do deliver benefits of increased absorption. Many companies promise these benefits, but not all technologies are created equal. So, are you really getting the technology and the benefit that they promise? Let’s take a closer, common-sense approach to understanding these products to help you delineate between which claims are accurate and which are not.

What are the technologies and how are they made?

Liposomes are nanosized, spherical emulsions consisting of phospholipids that form a bilayer membrane surrounding an aqueous core (A). Liposomes are mainly used to encapsulate water-soluble nutrients. The liposome bilayer wall can encapsulate a small amount (~5%) of lipid-soluble nutrient. Nanoemulsions are comprised of a single layer of emulsifier, usually phospholipids, that surrounds and encapsulates lipid-soluble nutrients (B).



Schematic depiction of differences between (A) Liposomes and (B) Nanoemulsions.

Both technologies require a high energy process to form nano-sized particles in a range of 100-200 nm in diameter. These particles are usually produced through ultra-sonication or ultra-high sheer homogenization, using microfluidizers, to achieve the nano-sized particle needed for stability in solution. In addition to size, the other significant factor regarding stability in aqueous solution is the charge that the phospholipids impart to the emulsion particle. Because of their size and overall charge, the encapsulated particles stay dispersed in water through Brownian motion. Dispersibility and constant motion eliminate the possibility of agglomeration of particles and precipitation (sediment) or flocculation (ringing) of the product. Size and charge are normally measured using dynamic light scattering particle size analyzers with the ability to measure zeta potential of the particles (total charge).

How well do they encapsulate the nutrients?

Nanoemulsions encapsulate lipid-soluble nutrients very efficiently, normally at 100%. If they fail to encapsulate the lipid nutrients, or become unstable, lipid material will separate from the matrix and float to the top of the aqueous environment, and ringing will be observed.

Conversely, liposome encapsulation efficiency is a little more difficult to determine. Since liposomes encapsulate water-soluble nutrients, the nutrient is located both inside and outside the liposome. Several factors play a role in controlling the encapsulation efficiency of liposomes. For example, the more phospholipid in the formulation, the more liposomes that are created. More liposomes mean more internal volume to encapsulate nutrients. However, 100% encapsulation of water-soluble nutrients is never possible because some amount of water-soluble nutrient always exists in the external aqueous environment. Furthermore, liposomes are not an impervious plastic bag, but more like a fabric bag through which water and nutrients can pass. Because of this, diluting liposomes with more water will certainly result in a lower encapsulation efficacy of nutrients as the system moves towards equilibrium.

What about liposome and nanoemulsion powders?

The bad news is nearly all powdered liposome formulations on the market are not truly liposomal. Most of these formulations only a blend of all the ingredients (phospholipids and nutrient) in a powder mixture. It may be claimed that the liposomes will self-assemble, spontaneously during digestion, but that is highly

doubtful. To create a true liposome powder, manufacturers first need to create liposomes, as previously described, then convert this formulation to a dry powder by freeze-drying or spray-drying. The question arises: Does drying come at the expense of the structure of the liposome and hence the bioavailability advantages? The answer is yes. Liposomes can only exist in water. Water must be inside and around the liposome to create the special pressure necessary to hold the liposome membrane in place. The liposome cannot maintain its three-dimensional shape if the water is removed. Water is essential to the stability of a liposome. The liposome three-dimensional shape is necessary to provide the increased absorption.

On the contrary, functional nanoemulsions containing oil nutrients can and are being dried in powder forms. However, the manufacturing process is extremely delicate and challenging. The process of removing water (via spray drying, drum drying, fluid bed drying, etc.) tends to destabilize the nanoemulsion's three-dimensional structure. Special care needs to be taken regarding the starch, dextrin, and other bulking agents intended to replace water in the system. Without the right combination of bulking agents, the nanoemulsions destabilize during the drying process, and their benefits are lost.

When the drying-formulation process is carefully controlled, it ultimately results in a powdered product that contains the three-dimensional nanoemulsion particles that were present in the aqueous medium prior to drying. So, when the powder is re-introduced into an aqueous system, the bulking agents dissolve into the water, and the nanoemulsions become fully dispersible again. The same nanoemulsion benefits are available in the powdered form with one very significant improvement. The second encapsulation by the bulking agent increases the protection of nutritional payload.

So what should I look for to help me determine if the technology is legitimate?

Follow these tips when investigating companies that sell liposomes and nanoemulsions…

1. Ask manufacturers for evidence to prove they are genuine.
2. Review the list of ingredients. Do they comply with your needed regulations and use?
3. What process do they use to manufacture the products?
4. Ask to see the certificate of analysis that shows particle size of the liposomes and nanoemulsions.
5. Look into the manufacturer's testing procedures.
6. Is the shelf life of the nutrient and product more than 12 months?
7. Do the products and company have independent, peer-reviewed clinical trials demonstrating their benefits? Will they share them?
8. Look into the manufacturer's Quality Assurance program – third party certifications.
9. ***Most importantly, always get a sample of the product first.*** If you dilute the product further in water, (a) does it easily dissolve further and look uniform? (b) does it remain dispersed? (c) does it ring or settle out over time.?

About 3i Solutions

3i Solutions is in the technology business. We're in the science and chemistry business. And, we're in the life-changing business. Through our proprietary, science-based solutions, 3i Solutions' technology and formulations improve how your products deliver better functional benefits. We increase absorption and bioavailability as well as extend the shelf life of products in industries like food and beverage, vitamins and supplements, and personal care products. We make the impossible possible.

Since 1997, 3i Solutions has expertly formulated and manufactured ingredients using proprietary encapsulation technologies. We continue to create new options for your products, by developing new ingredients to incorporate into different supplement forms like gummies and liquid dosages, food and beverage products like RTDs and drink powders, personal care products like spray-on lotions and many more. We push the

boundaries you haven't explored. We've been imagining, innovating, and implementing better ways for customers to create better products for nearly 30 years. We continue to expand our technologies to support new, preferred delivery formats. The impossible becomes possible.

Our unwavering commitment to Quality and continuous improvement make 3i Solutions a partner of choice for your development challenges. Our facility is Kosher & Halal certified and can support the manufacturing of these certified ingredients. We are NSF certified for Dietary Ingredients and hold Ohio Department of Agriculture accreditation for Hemp Processing. Our lab holds ISO/IEC 17025:2017 certification to provide results you can rely on.

Our Development team is focused on finding the custom solution that meets your specific needs. You provide the challenge, and our team creates the solution for your finished product needs.
Check us out at **www.3iSolutions.com.**

3i Solutions Offerings of Liposomes and Nanoemulsions

We encourage you to explore our offerings of aqueous liposomes and nanoemulsions under our VitaSperse® brand, powder nanoemulsions under our VitaDry® brand, and glycerin dispersions under our VitaSperse®-G brand. You can read more about our technologies **here.**

3i Solutions is always happy to send you samples of our technology and ready to support your project fully. To get a catalog of our offerings, or to start a new R&D project, reach out through our contact form on our website. **Contact Us.**

3i Solutions Studies of Bioavailability

You can find more on our website but here are a few references to studies that show 3i Solutions' technology advantages in bioavailability.

Kopec, R. & Li, Z. (2024) CoQ10 bioaccessibility and Caco-2 cell uptake improved with novel medium chain triglyceride encapsulation. **Food and Function**, 15(22), 10981-10986. **Link**

Kopec, R., Li, Z., Zhong, S. (2024) Carotenoid Bioaccessibility and Caco-2 Cell Uptake Following Novel Encapsulation Using Medium Chain Triglycerides. **J. of Dietary Supplements**, 121(10), 1-15. **Link**

Bhagavan, H., Chopra, R., Craft, N., Chitchumroonchokchai, C., Failla, M. (2007) Assessment of coenzyme Q10 absorption using an in vitro digestion-Caco-2 cell model. **Int. J. of Pharm**. 333, 112-117.

Miles, M., Horn, P., Miles, L., Tang, P., Steele, P., DeGrauw, T. (2002) Bioequivalence of coenzyme Q10 from over-the-counter supplements. **Nutrition Research** 22, 919-929.

About the Author, Scott Peters

Scott has been with 3i Solutions from the beginning, leading the product development advancements. He has contributed to all facets of *imagine*, *innovate*, and *implement* by mentoring several interns and entry-level employees, creating in the R&D lab, collaborating directly with customers, working with Quality, carrying out production—he's contributed to it all. Scott, along with colleagues, was responsible for all technology innovation and research until his appointment to General Manager in December 2022. Scott has more than 30 years of hands-on experience in nano- and micro-encapsulation leading to articles in a variety of professional publications. Scott's formulations cover a broad range, including drug delivery systems, cosmetics, nutritional supplements, and functional foods. Scott received a BA from the College of Wooster and two Master's degrees from Syracuse University.