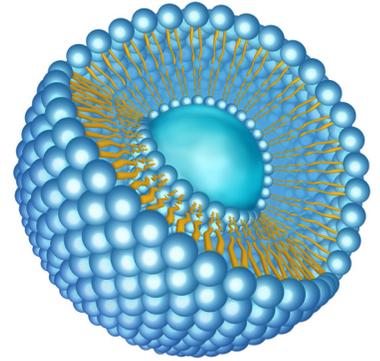


SUPPLEMENT DELIVERY SYSTEMS AND THE SCIENCE BEHIND BIOAVAILABILITY

Science continues to reveal the exciting health-promoting properties and therapeutic benefits of nutrients and natural compounds. However, despite their vast potential, many of these compounds have low bioavailability, meaning they are not efficiently absorbed by the body.¹

In order to realize the full health benefits of supplemental nutrients and various phytochemicals, we need to consume them in more bioavailable forms. Liposomes and nanoemulsions are two supplement delivery systems that are exponentially increasing the bioavailability of these powerful ingredients.^{2,3}



The Health-Promoting Potential of Phytochemicals

Nature is truly a treasure trove of phytochemicals —the biologically-active compounds found in roots, leaves, flowers, fruits, and plant seeds. The phytochemicals family encompasses a colorful cast of compounds, including:

- Anthocyanins, found in blue and purple fruits such as elderberry
- Terpenes, found in hemp
- Flavonoids, such as quercetin, resveratrol, and curcumin, found in fruits and roots
- Alkaloids, such as berberine

A diet rich in fruits and vegetables supplies the body with a diverse array of phytochemicals; in fact, phytochemicals may be a chief constituent responsible for the beneficial health effects associated with regularly eating those fruits and veggies.⁴ **However, a growing body of research indicates that taking higher doses of phytochemicals offers unique health benefits that we cannot obtain through consuming whole fruits and vegetables alone.**^{5,6}

For example, the flavonoid quercetin, found in apples, capers, onions, and berries, balances excessive histamine release and can provide relief to seasonal sufferers. However, high doses of at least 250 mg quercetin are needed to achieve this effect; for reference, you would need to eat 19 apples to obtain this much quercetin!^{7,8} Curcumin, the bright orange phytochemical found in turmeric root, supports a healthy inflammatory response and eases joint discomfort; however, it suffers from a similar problem in that high doses are required to achieve these effects.⁹

Traditional Supplement Delivery Systems Suffer from Low Bioavailability

For thousands of years, humans have utilized phytochemicals or plant compounds for their health-promoting properties. Traditionally, plant compounds have been prepared as teas, infusions, tinctures, and powders. These methods use heat, pressure, water, and alcohol to extract beneficial components from them.

With the emergence of the dietary supplement industry in the 20th century, manufacturers began to deliver plant compounds and other bioactive ingredients, such as vitamins and antioxidants, inside capsules made from vegetable cellulose or gelatin. Some manufacturers combine bioactive ingredients with excipients, pressing them together to form solid, smooth tablets. Tablets tend to have a long shelf life and are cheaper to manufacture than capsules.

Unfortunately, research indicates that plant compounds and other nutrients delivered in teas, tinctures, powders, capsules, and tablets suffer from poor bioavailability.^{10,11} Bioavailability is the extent to which a compound, such as a phytochemical, is absorbed and made available for use within a living system, such as the human body. Research indicates that many health-promoting phytochemicals have a low bioavailability when consumed in whole foods or encapsulated supplements.

For example, a mere 6.9% of quercetin glucoside, a form of quercetin found in foods, is absorbed in the gut.¹² Merely increasing one's intake of a phytochemical, such as quercetin, offers minimal improvements in bioavailability. Beyond a certain point, higher doses yield diminishing returns.¹³ The low bioavailability of many plant compounds may explain why high doses are required to produce beneficial health outcomes.

Phytochemicals aren't the only compounds with a poor absorption rate and low bioavailability in the human body. Our bodies also tightly regulate our absorption of specific vitamins and minerals, preventing us from effectively absorbing higher doses of certain nutrients, such as vitamin C and zinc.^{14,15} Simply increasing the amount of these nutrients that you consume typically doesn't solve the problem; for example, in the case of vitamin C, high doses of the traditional form of this nutrient, delivered in capsules or as a powder, triggers loose stools, causing a rapid elimination of the extra vitamin C.

Some compounds cannot be delivered to the body without significant degradation occurring first. For example, glutathione, your body's premier antioxidant, is delicate and easily broken down into its constituent amino acids in the gut, never even making it to the bloodstream.¹⁶

Gut Dysfunction Reduces Nutrient Absorption

An often-overlooked piece of the bioavailability puzzle is the gut microbiome's role in helping or hindering our ability to absorb phytochemicals and other nutrients. Research shows that our gut bacteria impact our ability to absorb quercetin, resveratrol, and berberine.^{17,18,19} Beneficial gut bugs, such as lactobacillus, appear to play a crucial role in the metabolism and absorption of plant compounds delivered in traditional delivery systems, such as capsules.²⁰ Inadequate levels of these helpful gut bugs, which is not uncommon in our society due to heavy antibiotic use and unhealthy diets, may impair our ability to fully realize the health benefits of natural ingredients delivered through traditional supplemental methods.

An unhealthy gut is also less able to absorb critical micronutrients, such as B vitamins and zinc. Intestinal epithelial cells form the interface between the inside of your gastrointestinal tract and your bloodstream; when these cells are damaged by imbalanced inflammatory responses, they are less able to take up nutrients from the gut into the bloodstream to distribute to cells and tissues.²¹ For these reasons, people struggling with gut health imbalances have an even greater need for highly bioavailable supplements and a delivery system that can bypass the constraints of digestion, allowing therapeutic phytochemicals and nutrients to be delivered directly into cells.

Liposomes and Emulsions: Powerful Solutions to the Bioavailability Problem

While nutritional supplements offer abundant potential for improving health, the bioavailability constraints posed by faulty delivery methods and poor gut health have bred skepticism among practitioners and consumers alike regarding the efficacy and overall benefits of supplementation. Fortunately, supplement delivery systems are evolving, and we now have an answer to the bioavailability problem — liposomes and nanoemulsions.

Liposomes are tiny bi-layered lipid bubbles approximately the width of a single human hair, and when manufactured correctly, are made of the same fats — phospholipids — as our own cell membranes. The two phospholipid layers of a liposome form concentrically; the outer layer has hydrophilic “water-loving” phospholipid heads at the surface, allowing the particle to mix with water. The molecule's core contains hydrophilic heads that face inward, allowing the liposome to carry water-soluble ingredients. The hydrophobic “water-fearing” tails of the phospholipid molecules meet in the molecule's outer layer, forming a lipid membrane.

Liposome absorption begins as soon as a liposomal supplement hits the tongue and mucosal lining of the mouth;²² circumventing absorption constraints posed by intestinal cells and the gut microbiome and passively absorb into capillaries and directly into cells. When quality liposomes are made with the same lipids that compose our own cell membranes, they effectively meld with the cell membrane, seamlessly and efficiently ushering ingredients into our cells.*

Once inside cells, these ingredients can directly target cellular function and stimulate crucial biochemical pathways. Research shows that liposomal delivery systems significantly enhance the bioavailability and efficacy of a wide array of phytochemicals and nutrients, including natural compounds with notoriously low bioavailability, quercetin, resveratrol, and glutathione.^{23,24,25}

Similarly, emulsions are monolayered spheres that carry fat-soluble ingredients. They are composed of a single-layer membrane of phospholipid molecules with the hydrophilic head facing the outside and the hydrophobic tail on the inside. These droplets have a large surface area and volume and, like liposomes, significantly enhance the bioavailability of the therapeutic phytonutrients, vitamins, or minerals they contain.

However, as suggested by their structure, they work best for carrying fat-soluble ingredients, such as vitamins A, D, E, K, carotenoids, and hemp extract among others.²⁶ For example, nanoemulsion delivery systems have been found to significantly improve the bioavailability of vitamin D, a fat-soluble vitamin, by 28% compared to conventional oral formulations.²⁷

When properly made, liposomes and emulsions should be composed of particles under 100 nanometers in diameter for optimal absorption, bioavailability, and efficacy. These compounds are referred to as "nanoliposomes" and "nanoemulsions."

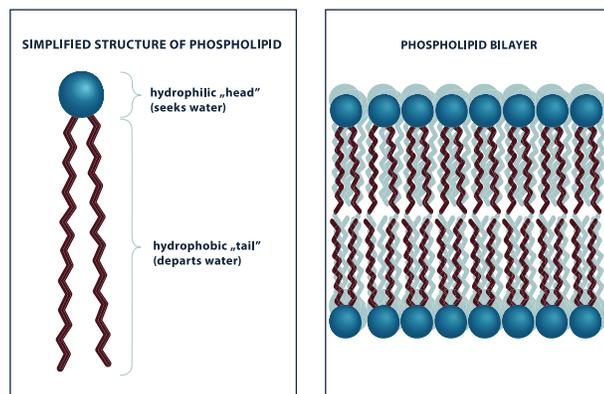
The uptake of ingredients from liposomes is vastly superior to the uptake of ingredients from traditional delivery systems, such as tinctures and capsules. For example, research demonstrates that liposomal vitamin C is 1.77 times (nearly 200%) more bioavailable than non-liposomal vitamin C.²⁸

SEDS: The New Kid on the Block in Supplement Delivery

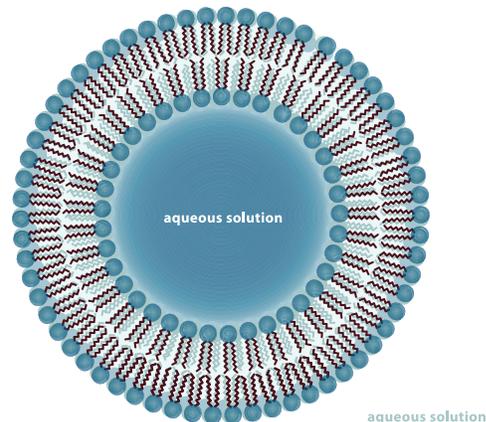
Self-emulsifying delivery system, SEDS for short, is a groundbreaking delivery process that rapidly delivers fat-soluble ingredients to the bloodstream. SEDS products carry ingredients in a capsule that dissolves upon contact with digestive system juices.

The ingredients are formulated as an emulsion prior to being encapsulated. When the capsule is consumed and enters the stomach, it dissolves and releases the intact nanoemulsion, which subsequently diffuses through intestinal membranes into the bloodstream. In this manner, SEDS offers a powerful bioavailability boost for ingredients, such as curcumin, that are not conducive to a purely liposomal delivery or that have a strong, unpleasant taste.*

By increasing the absorption and bioavailability of natural ingredients through nanoliposomal, nanoemulsion, and SEDS delivery systems, we can improve these compounds' bioactivity or net physiological impact on our bodies. When compared to old-school encapsulated supplements, these cutting-edge delivery systems provide more measurable, therapeutic outcomes that you can count on.²⁹



STRUCTURE OF LIPOSOME



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