



Solubilization of Carbon 60 in a Non-Toxic Solvent and Opportunities for Medical Development

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Abstract

We are reporting a breakthrough in the solubilization of Carbon 60 crystals using a non-toxic, non-polar solvent which enables for the first time the development of functional products containing C60 at effective concentrations. Over one hundred human conditions and diseases have been linked to the excess production of free radical molecules [1]. A solubilized C60 is uniquely capable of diffusing into cells and mitochondria to neutralize dangerous free radical molecules that cause damage to proteins, fats and DNA, resulting in disease. This innovation opens to doors to many opportunities to apply C60 to prevent or stop disease including cancer, autoimmune diseases, the Cytokine Storm as occurs in COVID and influenza infections, inflammatory conditions, radiation and sunburn.

Keywords: Solubilization; Carbon 60; Solvent

Background

C60 was first discovered in 1982 [2,3], but has always existed in nature. It can be found in common candle soot and any deposit of carbonaceous material. C60 is also known as carbon 60, C₆₀, fullerene, buckminsterfullerene, and buckyballs. It is composed entirely of carbon; 60 carbon atoms, bonded to each other in the shape of a soccer ball. It was named in honor of Buckminster Fuller, the inventor of the geodesic dome, because it has a geodesic structure.

A C60 molecule is composed of sixty carbon atoms bonded with alternating double and single bonds: 30 double bonds and 20 single bonds in all. A single C60 molecule is capable of neutralizing up to 24 free radical molecules via electron donation and six free radical molecules via proton acceptance. The protons become stuck inside the hollow carbon cage, unable to escape. The donation of electrons doesn't affect the stability of the C60 molecule, making it an irreversible process with no prooxidant activity, unlike other antioxidants. No other antioxidant neutralizes as many free radicals, making C60 a unique and powerful free radical sponge [4-8]. Since it can diffuse directly through cell and mitochondrial walls it irreversibly neutralizes free radical molecules extracellularly [9,10], as well as inside mitochondria and cells [11]. No other molecule is shaped like this, behaves in this manner, or has this capacity for irreversible neutralization of free radicals [12].

The overall size of the C60 molecule is 0.72 nanometers in diameter. This is only 2.7X the size of a water molecule and much smaller than other antioxidants. For example, Ascorbic Acid is

hydrophilic, 59.8 nm [13] in diameter and cannot diffuse through a cell wall. The C60 molecule is hydrophobic and small enough to pass through cell membranes and mitochondrial walls to neutralize free radicals at the site of formation. The only other antioxidant exhibiting some of these properties is melatonin, but with a lower capacity for neutralizing free radicals [14,15].

C60, like other forms of carbon, forms crystals. The buckyballs align and pack together loosely to form fluffy crystals or tightly to form crystals almost hard as diamond. This creates a problem for the application of C60 in medicine as the C60 molecules must be free to diffuse independently in order to be active in a biological system. Other C60 products are produced by grinding the C60 crystals to reduce particle size and increase surface area, but since the crystals are so hard, this is not a productive process, resulting in only partial solubilization of the C60. The crystals are too large to pass through cell membranes or the intestinal wall and any that do will be removed by the liver.

C60 has been known to be a powerful antioxidant molecule with medical potential for over 30 years [16]. Research has been stymied by the inability to safely dissolve crystalline C60 to produce a bioactive form. Researchers have tried various techniques over the past 30 years to solubilize C60 including Hansen solubility parameters [17], modeling [18-20], and artificial intelligence [21]. Solvents like toluene and tetrahydrofuran are effective but toxic. Most experiments have been performed using triglyceride oils, but solubility is low (0.9 mg/mL after mixing for two weeks) making it difficult to formulate a convenient and effective dose.

We have developed a process using components of essential oils including D-Limonene and Caryophyllene to fully solubilize C60 crystals into free bioactive molecules at a concentration of 16.7 mg/ml, which is twenty times what can be achieved in triglyceride oils and is sufficient for developing functional applications. We confirmed full dissolution via Transmission Electron Microscopy performed by NUANCE TEM at Northwestern University [22].

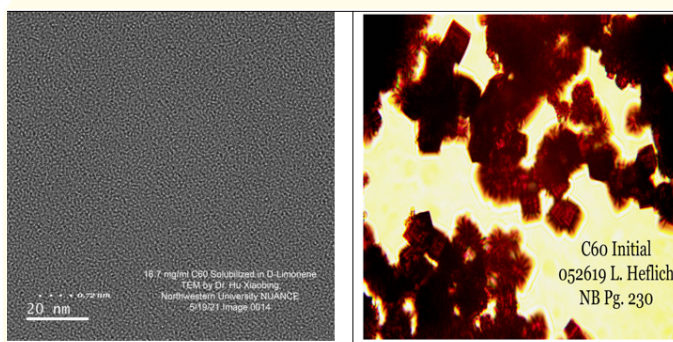


Figure 1: The image on the right shows typical C60 crystals at 1000X under a light microscope. The left image shows the fully dispersed C60 molecules under TEM microscopy (750,000X).

Prevention of damage due to toxins

C60 has been shown to prevent disease by a study of damage to liver tissue caused by the biotransformation of carbon tetrachloride [23]. C60 protected the liver from damage demonstrating its ability to penetrate liver tissues and neutralize free radicals [24]. Another study shows C60 to protect the liver against free radicals produced by the biotransformation of toxic materials [25].

Prevention of damage due to radiation

C60 has been shown effective in preventing damage from free radical molecules produced by exposure to nuclear radiation, space travel, cancer treatment and exposure to X-Rays. The radioprotective possibilities of C60 were reviewed by the department of Radiobiology University of Defense, Faculty of Military Health Sciences, Czech Republic [26]. They concluded “fullerenes offer a great potential to become radioprotectants with a possibility of repeated administration”. Another study compared C60 to amifostine, a commonly used radioprotective agent with significant adverse side effects and concluded that C60 was effective and exhibited no toxicity [27]. Hydrated C60 has been shown to protect DNA from ionizing radiation *in-vitro* and *in-vivo* by decreasing reactive species generated by exposure to X-rays [28].

Prevention of damage due to UV exposure

C60 has been shown to penetrate skin cells [29], where it neutralizes free radicals caused by exposure to UV radiation from sunlight [30-33]. Applying or ingesting solubilized C60 can prevent

sunburn systemically without blocking agents, allowing the skin to produce Vitamin D. This is especially relevant as many of the traditional sun-blocking and sunscreen agents are coming under safety scrutiny by FDA and may be banned from use, as PABA has been.

Anti-aging

C60 improves longevity by reducing oxidative free radical damage to DNA, fats and enzymes that accumulates over time [34]. Baati., *et al.* showed significant prolongation of the lifespan of Wistar rats by repeated oral administration of C60 dissolved in olive oil [35]. The study was designed to determine the toxicity of C60, but no toxicity was found at any level. Most interestingly, the rats taking C60 did not develop cancer as occurred in the control animals. A study in mice showed similar results [36]. Another study focuses on mTOR signaling pathways and antioxidant capabilities to explain how C60 slows aging [37].

Prevention of damage caused by oxidative stress

Other potential applications for solubilized C60 are human diseases involving Immunoglobulin E (IgE) and mast cell release. The ability of solubilized C60 to reduce free radicals will enable treatment of a wide variety of diseases that involve oxidative stress, inflammation and immune system dysfunction [38]. These include respiratory distress syndromes such as the cytokine storm in COVID-19, asthma [39,40], allergic rhinitis and urticaria; oral conditions such as periodontitis and gingivitis [41], autoimmune diseases such as rheumatoid arthritis [42], and scleroderma; and allergic responses such as celiac disease [43]. The common factor in all of these conditions is chronic inflammation [1], caused by excess free radical production.

Status of intellectual property

Fuller Research has been granted three patents based on solubilized C60

- US Patent 10,842,742 Dissolved C60 and Method of Producing Dissolved C60, issued November 24, 2020-covers using solubilized C60 to develop an edible gum-based strip.
- US Patent 11,400,113, Dissolved C60 and Method of Producing Dissolved C60, issued August 2, 2022-covers delivering solubilized C60 via nebulization directly to inflamed lung tissue as in COVID-19 and Influenza
- US Patent 11,484,508 Dissolved C60 and Method of Producing Dissolved C60, issued November 1, 2022-covers the solubilization process.
- delivering solubilized C60 via spray or powder directly to infected nasal passages (pending)

Conclusion

A solubilized C60 is uniquely capable of diffusing into cells and mitochondria to neutralize dangerous free radical molecules that

cause damage to proteins, fats and DNA, resulting in disease. This innovation opens doors to many opportunities to apply C60 to prevent or stop disease.

The company/team

Fuller Research, LLC, a Florida LLC, was formed in September of 2019 with the mission to develop C60 for medical and veterinary applications to benefit as many people and animals as possible. Please contact the author via LinkedIn.

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