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Mini Review

The Application of Nanocarbon Onion-Like Fullerene (NOLF) Materials in the Human Digestive System

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Abstract

Since the 1980s, carbon fullerene materials have been investigated for medical applications in humans. Fullerene materials are composed of carbon atoms and compatible with the human body. They reduce free radicals in cells, provide anti-inflammatory effects, and inhibit tumor growth in the body. However, the primary antioxidant benefit of fullerene materials might be the activation of nuclear factor (erythroid-derived 2) factor 2 (Nrf2) [1]. Nanocarbon onion-like fullerene (NOLF) materials have a high surface area to volume ratio, making them viable for transportation within the human body. These NOLF materials regulate the effects of free radicals in humans and animals, reducing tumor formation in cells or tissues. They aid in targeted drug delivery systems for various medical conditions, such as cancer therapy. However, nanocarbon onion-like fullerene materials' safety, manufacture, and dosage should be further evaluated and established for their therapeutic use in humans.

Keywords: *Biocompatibility; Duox Enzymes; Free Radical; Fullerene C60; Nanocarbon; Targeted Drug Delivery; Uracil*

Abbreviations

C60: carbon 60; CNO: Carbon Nano-Onion; DNA: Deoxyribonucleic acid; NOLF: Nanocarbon Onion-Like Fullerene; Nrf2: Nuclear Factor (Erythroid-derived 2) Factor 2

Introduction

History and development of fullerenes

Fullerene is an allotrope of carbon with catenated shells, which assumes an enclosed caged form. Fullerenes were first indentified in carbonaceous deposits in Russia, which contained non-graphitized and non-crystalline elements of carbon. In particular, an underground rock, shungite, contained high carbon content containing fullerene allotropes [2]. Over the last decade, derivatives of the rock have been used in medicinal substances, water purification, and metallurgy. One of the various structures of the carbon allotrope, fullerene C60 consists of icosahedral atoms. With the advent of nanotechnology, carbon fullerenes have been researched continuously since 1985. Japanese scientists advanced studies on the molecule [2]. At Rice University, Robert Curl, Harold Kroto, Sean O'Brien, and James Heath, finalized their research and publications on the carbon fullerene allotrope [3].

Further discoveries regarding the shape of the molecule led to the term buckminsterfullerene or buckyball. Later, Kroto (1992) confirmed the physical structure of fullerene, including its band lengths around the sixty carbon atoms. Generally, nanocarbon fullerenes have biocompatibility and double bond properties that promote the application of such substances in medicine, including the destruction of tumors and improving metabolic reactions [4,5].

Moreover, the fullerene molecules form a stable structure due to numerous carbon double bonds and diamagnetic and hydrophobic properties. Although carbon fullerene express double bonds at every atom, the structure integrates sp hybrid orbitals resulting in its symmetry [6]. From the stable structure of fullerene molecules, more configurations were discovered with variatioins in chemical properties. Numerous carbon rings make up the fullerene structure with an additional twelve ties with pentagonal forms. Sumio Ijima discovered onion-like carbon structures in 1980, which advanced the understanding of the allotrope [3,4].

In 1992, Daniel Ugarte developed a process to make nanocarbon onion-like fullerene (NOLF) with similar energies as the primary forms of the allotrope [7]. These NOLF allotropes have high biocompatibility properties in reaction with other molecules, allowing for their extensive applications in medicine and industry [8]. Fullerenes react with enzyme receptors affecting DNA and cell-signaling in the body.

Discussion

Fullerenes effects on physiological processes in the body

In humans, exposure to fullerene materials through dermal injection or inhalation results in adaptation in the body's physiological processes. However, significant adverse effects are not induced by the exposure to these fullerene materials as they are retained in cells. Due to nanocarbon fullerene substances' biocompatibility, they are readily absorbed in the body, such as the immune system [9]. Over time, specific physiological processes in the body can improve, including the immune system, coagulation, and homeostasis. In particular, most fullerene materials act as oxidizers by reducing free radicals around human cells as they infiltrate the core of tissues and organs [10]. Based on the free-radical scavenging mechanism in the body, the nanocarbon fullerenes do not negatively alter the cell's metabolic processes; instead, they improve such processes [11]. As a result, exposure to carbon fullerenes improves the metabolic processes and physiological systems in humans. However, the primary antioxidant benefit of fullerene materials might be through the activation of nuclear factor (erythroid-derived 2) factor 2 (Nrf2) [1].

Fullerenes effects on the human digestive system

Research on the effects of nanocarbon fullerene materials has shown benefits in the human digestive system. The fullerene molecules protect cells from free radicals during digestion and gastrointestinal metabolism. Through *in vivo* research, nanocarbon fullerenes were found to inhibit inflammation and tumorigenicity [12].

Due to nanocarbon fullerene materials' ability to absorb ultra-violet energy, they are used to excite chemical reactions in the body. The excitation of molecules in the presence of light gives rise to quantum reactions in cells and tissues [13]. In particular, nanocarbon onion-like fullerenes help destroy tumors and malignant tissues with photodynamic therapy.

Under photodynamic therapy, light energy is focused on body cells to stimulate reactive oxygen species, destroying malignant tissues. In the human digestive system, fullerene materials induce uracil and doux enzymes that destroy harmful bacteria in the body [14]. For such experiments, only pure fullerene materials are used to evaluate the influence on basic metabolic processes, especially in the digestive system. Over the past decade, these fullerene materials have been investigated to improve metabolic processes in the body for extensive periods [15]. However, nanocarbon fullerenes' use is controlled to prevent body organs and cells from permanent damage or destruction.

Through the administration of high-qualify nano-materials in the body, research can be advanced in various metabolic processes in line with the cellular mechanisms.

Conclusion

Nanocarbon onion-like fullerene materials have been investigated for therapeutic applications in the human body due to their biocompatibility and ability to improve metabolism. Fullerene materials were discovered from carbonaceous deposits, where their configurations and physical properties spawned research of the allotrope. Due to the compatibility with body cells and tissues, fullerene materials improve physiological processes over time despite limited alterations in functionality. The action of these fullerenes is based on free-radical scavenging process in the cells; however, the primary antioxidant benefit of fullerene materials might be through the activation of Nrf2. Under photodynamic therapy, the fullerene materials can be applied to destroy malignant cells in the human digestive system.

The future seems promising for the application of fullerene materials in specific gastrointestinal diseases and disorders. However, the outcomes in the manufacturing process of experimental-grade and pharmaceutical-grade fullerene materials can be inconsistent (even within the same batch), making it challenging to perform reliable assessments and reproducible studies of their biological benefits, biocompatibility, and potential toxicity. Also, their dosage, timing, and duration should be established for therapeutic use in specific conditions by evidence-based research. Further research on the potential beneficial effects and possible adverse effects of fullerene materials in human cells or tissues should be conducted to confirm or deny any medical advantages associated with their chemical structures and properties.

Conflict of Interest Statement

The authors declare that this paper was written in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

Supplementary Note

This paper, as a mini-review, is designed as a brief introduction to nanocarbon onion-like fullerenes (NOLFs), regarding their application in gastrointestinal medicine. Other articles have been or will be published on the application of NOLFs in the cardiovascular system, respiratory system, neurological system, veterinary medicine, agriculture, pharmacology and toxicology, and other topics. These distinct mini-review articles could have been combined into a much lengthier review or research article. However, to have done so, the subject matter would have resulted in only one publication in one journal, to the exclusion of other medical specialties. The purpose of these papers is to disseminate the purported biocompatibility and beneficial effects of NOLFs to the broadest audience of students, researchers, and medical practitioners as possible. The authors hope that the introduction to NOLFs' application in various and diverse disciplines spawns curiosity and further research regarding NOLFs and variegated fullerene materials. Fullerene materials seem poised to become a vital part of the future of medicine, veterinary medicine, and agriculture. However, more research is needed to determine any adverse effects of their long-term use. Also, the NOLF manufacturing process requires standardization to provide consistent quality and batch samples. Dosage and duration of treatment with fullerene materials for specific conditions need to be established by evidence-based research.

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