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Physical Chemical Analysis of Fullerene Aqueous Dispersions

VALERY V. SMIRNOV[1,2]; E. A. TURETSKIY[1,2]; S. M. ANDREEV[2]; N. N. SHERSHAKOVA[2]; A. A. SHATILOV[1,2]; A. V. TIMOFEEVA[1,2]; K. V. KOZHIKHOVA[1]; M. R. KHAITOV[2]

[1]*I. M. Sechenov First Moscow State Medical University of the Ministry of Health of the Russian Federation (Sechenov University), 8, Trubetskaya str., Moscow, RU-119991, Russian Federation;*
[2]*NRC Institute of Immunology FMBA of Russia, 24, Kashira Highway, Moscow, RU-115522, Russian Federation*

Correspondence: vall@mail.mipt.ru

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1. Introduction

Despite being insoluble in most polar solvents [4, 5], fullerene C60 can form stable colloid dispersions in aqueous media [2, 3]. Such Aqueous Fullerene Dispersions (AFD) have a number of practical applications, including use in biology and medicine as anti-inflammatory agents [6]. For this purpose, AFDs are obtained by dissolution of fullerene C60 in 1-methylpirrolidone (MP), mixing it with aqueous solution of appropriate stabilizer and removing MP by dialysis through semi-permeable membrane [1]. This method has recently been improved significantly by substituting dialysis with more efficient process of tangential flow filtration. In this work, a number of physical-chemical characteristics of AFD, obtained by this method, are described.

2. Materials and methods

UV-Vis absorption spectra were recorded on a double beam spectrophotometer Cary 100 (Agilent Technologies) in the range of 190-800 nm using 1-cm quartz cell. Sizes of nanoparticle and their ξ-potential were measured using method of photon correlation spectroscopy performed on a “Photocor Compact-Z” (Photocor Ltd., Russia) analyzer. Freeze-dried dispersions have been studied using Fourier transformed infrared spectroscopy (FTIR) spectra recorded on a Bruker Alpha IR spectrometer (attenuated total reflectance (ATR) measurements). Fullerene within AFS has additionally been identified using matrix assisted laser desorption/ionization time-of-flight (MALDI-TOF, MicroflexTM LT MALDI-TOF, BrukerDaltonics) mass spectrometry. For elemental analysis of fullerene nanoparticles was used 2400 series II Perkin Elmer element analyzer.

3. Results

UV-Vis spectra showed a wide band of absorption from 550 to 400 nm and 3 peaks at 230, 270 and 340 nm. As with dialysis method, 340 nm peak has shown great linearity of calibration curve and is suggested to be used for quantitative analysis. Number and position of peaks did not depend of the particle size, which varied greatly, depending on stabilizer used. Hydrodynamic radius of particles in unstabilized AFD has been established as roughly 50 nm and two to six times that for AFDs stabilized with different poloxamers and polysorbates. ζ-potential was estimated as roughly -15 mV for all dispersions studied. FTIR spectra of freeze-dried samples were compared to spectra obtained from pristine fullerene. While all the major peaks are retained, a number of small emerging peaks is observed. The latter can be attributed to presence of water and MP within the freeze-dried powder. This can be confirmed by elemental analysis, which showed 2.28% nitrogen and 1.11% hydrogen content within fullerene freeze-dried sample. These results indicate water and MP presence within fullerene clusters. The possibility of hydrogen and nitrogen being covalently bound to fullerene within clusters have been excluded by applying MALDI-TOF mass-spectrometry, results of which clearly show a singular peak at m/z=720.

4. Conclusions

Results described in this work could be useful to elucidate AFD physical and chemical properties. Fullerene cluster’s ability to incorporate light molecules, shown here on example of MP and water, could be used in the future for small molecule drug delivery and controlled release.

References

1. *Andreev S.: Study of Fullerene Aqueous Dispersion Prepared by Novel Dialysis Method: Simple Way to Fullerene Aqueous Solution Fullerenes, Nanotubes and Carbon Nanostructures., 9(23): 792–800 (2015).*
2. *Andrievsky G. V.: On the production of an aqueous colloidal solution of fullerenes Journal of the Chemical Society, Chemical Communications, (1995).*
3. *Chen K.L., Elimelech M.: Aggregation and deposition kinetics of fullerene (C60) nanoparticles – Langmuir., (2006).*
4. *Marcus Y.: Solubility of C60 Fullerene, The Journal of Physical Chemistry B., 13 (105): 2499–2506 (2001).*
5. *Semenov K.N.: Solubility of light fullerenes in organic solvents Journal of Chemical and Engineering Data, (55): 13–36 (2010).*
6. *Shershakova N.: Anti-inflammatory effect of fullerene C60 in a mice model of atopic dermatitis. // Journal of nanobiotechnology., 14: 8 (2016..*