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TOXIC EFFECTS OF C60 FULLERENE NANOPARTICLES: A REVIEW PAPER

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Abstract

While several new reports have portrayed the toxicity of water-soluble C60 fullerene nanoparticles, none have detailed the toxicity coming about because of the inhalation openings to C60 fullerene nanoparticles or microparticles. To address this information hole, we presented male rodents to C60 fullerene nanoparticles (2.22 mg/m3,55 nm width) and microparticles (2.35 mg/m3, 0.93 mm distance across) for 3 h daily, for 10 back to back days utilizing a nose-just openness framework. Nanoparticles were made using an aerosol vaporization and buildup measure. Nanoparticles and microparticles were exposed to high-pressure liquid chromatography (HPLC), XRD, and scanning laser Raman spectroscopy which in total demonstrated no substance change of the C60 fullerenes happened during the aerosol generation. At necropsy, no gross or minuscule sores were seen in one or the other gathering of C60 fullerene openings rodents. Hematology and serum science results discovered genuinely critical contrasts, albeit little in extent, in both openness gatherings. Examinations of bronchoalveolar (BAL) lavage liquid boundaries distinguished a huge expansion in protein fixation in rodents presented to C60 fullerene nanoparticles. BAL liquid macrophages from both openness bunch contained earthy colored shades, steady with C60 fullerenes. C60 lung molecule troubles were more noteworthy in nanoparticle-uncovered rodents than in microparticle-uncovered rodents. The determined lung affidavit rate and testimony parts were 41 and half more noteworthy, individually, in the C60 fullerene nanoparticle–uncovered gathering than in the C60 fullerene microparticle–uncovered gathering. Lung half-lives for C60 fullerene nanoparticles and microparticles were 26 and 29 days, individually. In rundown, this first in vivo appraisal of the toxicity coming about because of inhalation openings to C60 fullerene nanoparticles and microparticles discovered negligible changes in the toxicological endpoints analyzed. Extra toxicological appraisals including longer term inhalation openings are expected to build up a superior and more definitive understanding of the likely toxicity of breathed in C60 fullerenes whether in nanoparticle or microparticle structure.

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1. INTRODUCTION

Due to the remarkable physicochemical properties of nanomaterials, intense interest and eagerness have encircled their utilization in business and purchaser items. Notwithstanding, this energy has been tempered by the absence of defined information concerning the expected unfavorable wellbeing and ecological results of these nanomaterials. As nanomaterials like C60 fullerenes continue to advance into purchaser items, people, and the climate will be increasingly presented to these materials. In the main reporting of the making of man-made C60 fullerenes, [1] theorized that "Because of its steadiness when framed under the most vicious conditions, it could be broadly appropriated in the universe." Indeed proof exists that proposes C60 fullerenes have existed on earth for a considerable time. C60 fullerenes happen in the climate from normal and anthropogenic sources, for example, volcanic emissions, backwoods fires, and the burning of carbon-based materials. Truth be told, ecological C60 fullerenes have been revealed in 10,000-year-old ice center examples [2] and dinosaur eggs [3]. As of late air tests from metropolitan climates have been appeared to contain fullerenes [4] demonstrating that people are presented to ecological fullerenes by means of inhalation. One specific trouble in studying the toxicity of C60 fullerenes in organic frameworks is that they are not soluble in water [5]. To beat this trouble, strategies that use the natural dissolvable tetrahydrofuran (THF) to make water-soluble suspensions of C60 fullerenes have been created [6]. Utilizing these water-soluble C60 fullerene suspensions, several investigations have detailed that openness to C60 fullerenes causes toxicity in different organic entities. Adolescent bass fish were accounted for to have increased lipid peroxidation in the brain and glutathione exhaustion in their gills in the wake of being put in 0.5-ppm water-soluble C60 fullerenes for 48 h [7]. In vitro examines have revealed cytotoxicity in human cells presented to water-soluble C60 fullerenes because of the creation of responsive oxygen species [8]and lipid peroxidation [9]. Others point out that the expulsion of THF in the arrangement of water-soluble fullerenes as portrayed in these examinations is incomplete (Andrievsky et al., 2005; Gharbi et al., 2005). One in vitro study reports that less than 10% of the suspension is lingering dissolvable and that controls for this leftover dissolvable didn't add to receptive oxygen creation or cell demise [9]. As opposed to these findings are considers performed by others that report no related toxicity or useful and defensive impacts of C60 fullerenes [10]. Within established researchers, opinions are blended regarding the toxicity and security of C60 fullerenes. Given the potential for human openings to C60 fullerenes from the climate, that no past inhalation toxicity investigation of C60 fullerenes has been led and most of studies reporting the toxicity of C60 fullerenes have used water-soluble fullerenes, Some analyst continued to direct an inhalation openness study focused on an expansive appraisal of various in vivo toxicological endpoints. The goals of this examination were to (1) make stable climates of nanoparticle and microparticle C60 fullerenes without the

utilization of water or solvents, (2) think about the toxicity of C60 fullerenes in nanoparticle and microparticle structure, and (3) determine the lung weight and toxicokinetics of nanoparticulate and microparticulate C60 fullerenes. [11]

II. DISCUSSION and CONCLUSION

They have finished the primary inhalation toxicity and lung trouble investigation of C60 fullerene nanoparticles and microparticles. Because of the restricted measure of information accessible on the toxicity of C60 fullerenes, especially in mammalian species, we decided to examine a broad assortment of toxicological endpoints to survey C60 fullerene toxicity. As opposed to other toxicity investigations of C60 fullerene nanoparticles, our specialized approach didn't need the C60 fullerene material to be water-soluble eliminating the requirement for solvents. All through the aerosol generation measure, the C60 fullerene test material remained dry. Aerosol tests were gathered from the nose port of the openness unit. These examples were exposed to broad substance and physical portrayal and looked at to the obtained C60 fullerene test material. HPLC, XRD, and scanning laser Raman spectroscopy results in total indicate that no synthetic alteration happened during the aerosol generation measure for either nanoparticle or microparticle C60 fullerenes. TEM, SMPS, and course impact or results indicate that the particles were respirable in size. Overall, 10 successive long periods of openness to C60 fullerene nanoparticles or microparticles brought about minimal toxicity in rodents. There were no critical contrasts in body or organ loads between the C60 fullerene nanoparticle–or microparticle–uncovered rodents and the controls. Broad histopathological investigation didn't recognize any openness related injuries in the respiratory parcel or some other tissues examined. Rodents presented to nanoparticle C60 fullerenes had slight genuinely critical diminishes in red platelets, hemoglobin, and pack cell volume. Notwithstanding, these distinctions were 3% or less thought about to controls and are of uncertain toxicological importance. The hematological boundaries in the microparticle-uncovered rodents had the most contrasts in hematology perceptions. White blood cells were altogether diminished by 21%, monocytes were diminished by 73%, eosinophils were diminished by 55%, and platelets were diminished 13% comparative with controls. Albeit not genuinely huge, the nanoparticle-uncovered rodents had a 55% reduction in monocytes, a 18% increase in eosinophils, and a minimal reduction in platelets comparative with controls. Blood SDH, a hepatic catalyst, was diminished in nanoparticle-uncovered rodents and increased in microparticle-uncovered rodents, while bile acids were likewise diminished in nanoparticle uncovered rodents and increased in microparticle-uncovered rodents, suggesting an openness related hepatic impact for both nanoparticulate and micron-particulate openings. Be that as it may, no hepatic injuries were found in either openness gathering. CK focus was essentially increased in microparticle-uncovered rodents. This finding is especially interesting since human epidemiological investigations have announced that times of increased particulate focuses in metropolitan environments are related with an increased danger of myocardial infarction [12]. As was the situation for the liver, no C60-induced injuries were seen in the hearts of either nanoparticle-or microparticle-exposed rodents. BAL liquid examination of nanoparticle-and microparticles exposed rodents didn't uncover any

checked changes in BAL liquid aside from increased protein fixation in C60 fullerene nanoparticle–uncovered rodents. Albeit not genuinely huge, BAL liquid polymorphonuclear (PMN) cells in nanoparticle exposed rodents were more factor than the other openness gatherings. This fluctuation was because of 2 of the 10 rodents in the nanoparticle-uncovered gatherings that had BAL liquid PMN cell tallies of 114 and 39cells/µl. The remaining eight rodents had PMN cell tallies that went from 0 to 3cells/µl. excluding these two rodents from the nanoparticle gathering, the average PMN cells in the nanoparticle bunch are 3.0 ± 2.4 PMN cells/µl, which is equivalent to the control and microparticle-uncovered bunch averages. The critical increases in the proinflammatory cytokines, TNF-an and IL-1b, in the microparticle-uncovered bunch BAL liquid examples are reminiscent of the presence of aspiratory inflammation. Be that as it may, histological examination of the lungs didn't distinguish C60 fullerene–induced sores in any of the openness gatherings. True to form, the determined lung day by day testimony rate and affidavit portion of C60 fullerene nanoparticles were 41 and half more noteworthy, individually, than the microparticle-uncovered rodents. It is especially interesting that the distinctions in molecule sizes between the two openings just brought about a 3-day contrast in C60 molecule half-lives in the lung. These findings recommend that C60 nanoparticle and microparticles might be eliminated from the rodent lung by means of a typical instrument. In contrast with C60 fullerenes, investigation of another carbon allotrope, carbon dark (1.1 µm particles, 1 mg/m3, 6 h/day, 5 days/week, for 13 weeks), revealed a 64-day half-life in the lungs of rodents [13]. Like the current investigation of fullerenes, there were no histopathological findings related with carbon dark openings at this openness focus. Consistent state lung troubles are not expected to be reached until rodents are uncovered over roughly 5 half-lives, which in the current investigation are roughly 130 days of openness for nanoparticles and 145 days for microparticles. Since consistent state lung loads were not came to during this investigation, it is conceivable that exposure related toxicological findings will be found in longer span considers. The way that we couldn't recognize C60 fullerenes in the blood doesn't block the chance of biotransformation in the lung with the end goal that C60 is delivered imperceptible using our scientific procedure. This chance could be relieved by the utilization of a carbon isotope–marked C60 fullerene in the aerosol generation framework. By and by, this methodology isn't achievable for studies, for example, our own because of the absence of isotope-marked fullerenes in adequate ads up to direct controlled aerosol openings. Comparable examinations have utilized 13C isotope–named carbon nanoparticle in an entire body openness chamber at 180 µg/m3 (22 nm) for 6 h [14]. 24 hours subsequent to terminating openness, no critical changes in lung 13C were noticed, 13C was found in the liver yet not in the heart, brain, or kidney. It was hazy whether the 13C in the liver was moved through the aspiratory flow or was cleared from the lung through the muco-ciliary elevator, gulped, and retained from the stomach related lot into the splanchnic course and conveyed to the liver. The nanoparticle openness focus tried in this examination is in overabundance of those normal to be found within the climate. Airborne nanoparticles (<100 nm in breadth) in metropolitan conditions have been estimated at mass fixations up to 1.58 µg/m3 and molecule focuses as high as 2.9 × 104 particles/cm3 [15]. The present study tried fullerene nanoparticle focuses that were roughly

multiple times more prominent in mass fixation and 35 times more prominent in molecule focus. Another investigation of carbon nanotubes in the conditions where these materials are handled and moved discovered mass focuses as high as 53 µg/m3 in the climate [16]. The mass focus tried in the current investigation was around 41-overlay more noteworthy in mass focus. There are by and by no reports of airborne fullerene focuses in word related conditions for correlation with the current investigation. Hence, the openness focus utilized in this investigation was considered an suitable starting point for the evaluation of momentary C60.

Table 1: Lung Deposition and Clearance Parameters

Exposure group	k_{el}	$t_{1/2}$	C_o	α	A_e
Nanoparticle	0.0271	26	59.3	6.77	249.5
Microparticle	0.0237	29	41.0	4.60	194.2

Note. k_{el} = lung clearance note constant; $t_{1/2}$ = half life (days); C_o = lung burden at $T = 0$ (day 10) (mg); α = deposition rate constant (mg/day), A_e = steady-state lung burden (mg).

III. REFERENCES

[1] H. W. Kroto, J. R. Heath, S. C. O'Brien, R. F. Curl, and R. E. Smalley, "C60: Buckminsterfullerene," Nature, 1985, doi: 10.1038/318162a0.

[2] L. E. Murr, E. V. Esquivel, J. J. Bang, G. De La Rosa, and J. L. Gardea-Torresdey, "Chemistry and nanoparticulate compositions of a 10,000 year-old ice core melt water," Water Res., 2004, doi: 10.1016/j.watres.2004.08.010.

[3] Z. Wang et al., "Fullerenes in the fossil of dinosaur egg," Fuller. Sci. Technol., 1998, doi: 10.1080/10641229809350232.

[4] S. Utsunomiya, K. A. Jensen, G. J. Keeler, and R. C. Ewing, "Uraninite and fullerene in atmospheric particulates," Environ. Sci. Technol., 2002, doi: 10.1021/es025872a.

[5] R. S. Ruoff, D. S. Tse, R. Malhotra, and D. C. Lorents, "Solubility of C60 in a variety of solvents," J. Phys. Chem., 1993, doi: 10.1021/j100115a049.

[6] S. Deguchi, R. G. Alargova, and K. Tsujii, "Stable dispersions of fullerenes, C60 and C70, in water. Preparation and characterization," Langmuir, 2001, doi: 10.1021/la010651o.

[7] E. Oberdörster, "Manufactured nanomaterials (fullerenes, C60) induce oxidative stress in the brain of juvenile largemouth bass," Environ. Health Perspect., 2004, doi: 10.1289/ehp.7021.
[8] C. M. Sayes et al., "The differential cytotoxicity of water-soluble fullerenes," Nano Lett., 2004, doi: 10.1021/nl0489586.
[9] C. M. Sayes, A. M. Gobin, K. D. Ausman, J. Mendez, J. L. West, and V. L. Colvin, "Nano-C60 cytotoxicity is due to lipid peroxidation," Biomaterials, 2005, doi: 10.1016/j.biomaterials.2005.05.027.
[10] G. Andrievsky, V. Klochkov, and L. Derevyanchenko, "Is the C60 fullerene molecule toxic?!," Fullerenes Nanotub. Carbon Nanostructures, 2005, doi: 10.1080/15363830500237267.
[11] G. L. Baker et al., "Inhalation Toxicity and Lung Toxicokinetics of C60 Fullerene Nanoparticles and Microparticles," Toxicol. Sci., 2008, doi: 10.1093/toxsci/kfm243.
[12] A. Peters, D. W. Dockery, J. E. Muller, and M. A. Mittleman, "Increased particulate air pollution and the triggering of myocardial infarction," Circulation, 2001, doi: 10.1161/01.CIR.103.23.2810.
[13] A. Elder, R. Gelein, J. N. Finkelstein, K. E. Driscoll, J. Harkema, and G. Oberdörster, "Effects of subchronically inhaled carbon black in three species. I. Retention kinetics, lung inflammation, and histopathology," Toxicol. Sci., 2005, doi: 10.1093/toxsci/kfi327.
[14] G. Oberdörster et al., "Extrapulmonary translocation of ultrafine carbon particles following whole-body inhalation exposure of rats," J. Toxicol. Environ. Heal. - Part A, 2002, doi: 10.1080/00984100290071658.
[15] L. S. Hughes, G. R. Cass, J. Gone, M. Ames, and I. Olmez, "Physical and chemical characterization of atmospheric ultrafine particles in the Los Angeles area," Environ. Sci. Technol., 1998, doi: 10.1021/es970280r.
[16] A. D. Maynard, P. A. Baron, M. Foley, A. A. Shvedova, E. R. Kisin, and V. Castranova, "Exposure to carbon nanotube material: Aerosol release during the handling of unrefined single-walled carbon nanotube material," J. Toxicol. Environ. Heal. - Part A, 2004, doi: 10.1080/15287390490253688.