



An Invisible Threat to Public Health: Nano-Sized Colorants in Hair Fiber

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Dear Editor-in-Chief

Alopecia, generally called as hair loss, can be caused by genetic factors, aging and psychological stress and lead to a heavy mental stress or traumatic event for those who go through hair loss (1). For the purpose of preventing, decelerating, and concealing alopecia, various types of products, such as anti-hair loss shampoo, relevant medicines and hair fibers, have been presented with the gradual increase in their consumer market size. Especially, the rapid growth in the hair fiber market in the cosmetic industry have been observed due to its convenience and versatility.

Hair fiber product is a mixture of chemical substances, including cellulose, silica, and viscose rayon etc., which are covered with a wide variety of colorant powders. Colorants are classified using Colour Index (CI), which can be identified by a five-digit number and grouped to numerical ranges according to chemical structures (2). The most widely used hair fiber colorants are carbon black (CI 77266, black color), iron oxide red (CI 77491, red color), yellow (CI 77492, yellow color) and black (CI 77499, black color), titanium dioxide (CI 77891, white color) and zinc oxide (CI 77947, white color).

The colorants have a wide range of sizes from micro to nano, for example, CI 77891 (white) is comprised with 17-35% of nanoparticles (NPs), while CI 77492 (yellow) showed more than 50 % of NPs

(3, 4). NPs are generally known to be smaller than 100 nm at least one dimension, which have the high surface area-to-volume ratio resulting in an enormous reactivity. In the process of applying and rinsing hair fibers, inorganic colorants flow with fluids and enter into the environment stealthily, resulting in the possibility to exert adverse toxicological effects by entering into organisms through ingestion or inhalation (5). Iron oxide red, black that both in nano and micro particles (7 to 30 and over 100 nm) were shown in vitro genotoxicity that breaks DNAs in mammalian cells (3). Furthermore, not only nano particles, but bulk of iron oxide red (680 nm) have a potential of respiratory problems that they can permeate the pulmonary epithelium (6). Both of nano and micro size TiO₂ (14 to 62 nm and 160 to 530 nm) were shown cytotoxic activity with increasing reactive oxygen species in Syrian hamster embryo cells (7). In vivo study identified negative results that rats had shorter telomeres in the lung when they exposed the sizes of 135, 305 and 900 nm (4). In oral acute toxicity test of nano and bulk zinc oxide particles (13 to 68 and 94 to 199 nm) to female Wistar rats, both sizes affected weight loss and accumulation in kidney and liver (8). Moreover, low concentration of zinc oxide NPs (100 nm) for 7 days induced several noxious effects to brain tissues and induced oxidative stress, DNA fragmentation (9).



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In addition, the International Agency for Research on Cancer (IARC) classified both carbon black and titanium dioxide as the Group 2B; possibly carcinogenic to humans (10). Table 1 summaries

nano-sized colorants' CI, molecular formula, colors, nanoparticle composition ratios, and possible toxicological effects.

Table 1: Summary of colorants using in hair fiber products (2-4, 7, 9, 10)

<i>Color-ant</i>	<i>Colour Index (CI)</i>	<i>Nano particle</i>	<i>Molecular Formula</i>	<i>NP Composition Ratio%</i>	<i>Toxicological Effect</i>
Black	CI 77266	Carbon Black	C	-	Carcinogenic
Red	CI 77491	Iron Oxide Red	Fe ₂ O ₃	Less than 50	Genotoxic
Yellow	CI 77492	Iron Oxide Yellow	FeO(OH) · xH ₂ O	More than 50	Respiratory Problems
Black	CI 77499	Iron Oxide Black	FeO · Fe ₂ O ₃	Less than 10	Genotoxic
White	CI 77891	Titanium Dioxide	TiO ₂	17-35	Cytotoxic
White	CI 77947	Zinc Oxide	ZnO	-	Genotoxic

These inorganic colorants, containing nano to micro size particles, are also widely applied as additive materials in many industrial fields including textiles, plastics, cosmetics etc. (5, 7). Only the European Commission has regulated a limited number of colorants based on purity criteria and maximum concentration (2). Since we cannot rule out the possibility of colorants to cause adverse environmental and public health consequences, further research on the toxicity of hair fibers is necessary to provide scientific information for an effective legislation requiring manufacturers to present chemical composition and toxicity of the products containing nano-colorants.

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Conflict of interest

The authors declare that there is no conflict of interest.

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