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Safety of Color Additive: Titanium Dioxide

Titanium dioxide (TiO_2) is a naturally occurring ore with physical properties that make it a bright white pigment. As such, it is an inert (non-reactive) pigment that is used to color confectionery goods, cheeses, icings, frozen desserts, non-dairy creamers, dried soup, pharmaceutical products and cosmetics. In addition, recent applications have been suggested where TiO_2 could directly coat foods to reduce oxidation on the food surfaces.

Titanium dioxide is typically utilized in these products as a white color because of its brightness and high refractive index (> 2.6), which determines the degree of opacity that a material confers to the host matrix. In addition, when combined with other colors, soft pastel shades can be achieved. The high refractive index, surpassed by few other materials, is a property of TiO_2 particles in the sub-micron scale, typically in the range of 200 to 1000 nm, and allows TiO_2 to be used at relatively low levels to achieve its technical effect as a white color. When the particle size drops below this range, the refractive index also drops dramatically, making TiO_2 transparent and no longer appropriate to provide color. Manufacturing of TiO_2 particles in the nanoscale range (20-60 nm) requires specific technological engineering and results in a material with very different properties intended to perform other functions, such as antimicrobial coating, UV filter and other applications, but not as a pigment. A review of nanomaterial manufacturer websites easily reveals the intended particle size range of nanomaterials.

Regrettably, the scientific principles behind the physical and technical properties of pigment TiO_2 have frequently been overlooked or misused in the literature, including but not limited to the Weir et al (2012) article. The terms Ti, TiO_2 and nanosized TiO_2 are unfortunately often used interchangeably, resulting in confusion of the pigment with the nanosized material and incorrect public perception of the food color safety. Currently, the accepted definition of nanomaterial in the European Union refers to a material with more than 50% of its particles with size of at least one dimension lower than 100nm.

In response to government recommendations to determine which products contain nanomaterials or otherwise involve the use of nanotechnology, IACM has commented to express concerns that existing materials, such as pigment TiO_2, not designed and not behaving as a nanomaterial, may fall into the range between 100 nm and 1000 nm (1 micrometer; µm), a range often considered by regulatory bodies, and would likely be captured by potential regulatory expansion of the nanomaterial range. IACM feels strongly that no additional safety information is needed for existing materials that are not engineered to acquire “nano” properties, but that might have an average particle size that falls in this range.

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the European Food Safety Authority (EFSA) have both evaluated TiO_2 and support its use as a food color. JECFA reevaluated food color TiO_2 as recently as 2010 and found no reason to assign an acceptable daily intake (ADI) to the material. The US FDA approved pigment TiO_2 as a food color additive in 1966 with the stipulation that the additive was "not to exceed 1% by weight" (21 CFR 73.575) and maintains its status as an exempt from certification color. These bodies consider the material to be safe for intended use as a food color.