Detection of titanium dioxide particles in human, animal and infant formula milk

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ABSTRACT

Titanium (Ti) dioxide (TiO_2) nanoparticles (NPs) are massively manufactured for countless industrial applications for their white pigment, UV filter and photocatalytic properties. They are classified as potential carcinogens to humans by inhalation and banned from food applications in France and Europe due to their suspected toxicity. Present in daily life products, medicine, agriculture, building paints and coatings, water and air remediation systems, they have been detected in water, air, and soils. Their presence in mammals remains however underexplored. **Here, we investigated the existence of an actual contamination by TiO_2-NPs of milk, a proxy for both maternal and offspring exposure.** We analyzed human, animal, and infant formula milk samples using single particle inductively coupled plasma mass spectrometry (sp ICP-MS) and by synchrotron radiation-based X-ray fluorescence and absorption approaches at LUCIA beamline. We found that Ti microparticles and nanoparticles were present in all the samples tested, and characterized their size and concentration. Chemical speciation of Ti indicated predomination of rutile TiO_2, followed by anatase TiO_2, and to a lesser extent other Ti-bearing minerals (ilmenite $FeTiO_3$, titanite $CaTiSiO_5$, or pseudobrookite Fe_2TiO_5). We found variations in the levels of Ti in milk that depended on the genetic background in cows, and on unrecognized factors in humans. These results shed light on the existence of an exposure to Ti particles of humans at all ages who consume milk, including newborns from birth until weaning. They further raise concerns regarding the potential impact on health and development of mammals, particularly in the postnatal period which is critical for the development of mammalian physiological functions.

REFERENCES

1.Rivard C., (…) Burtey A. *Science of the Total Environment* Volume 994, 10 September 2025, https://doi.org/10.1016/j.scitotenv.2025.180040
2.Communiqué de presse SOLEIL Synchrotron « Du dioxyde de titane détecté dans le lait, malgré l'interdiction du E171 » https://www.synchrotron-soleil.fr/fr/actualites/du-dioxyde-de-titane-detecte-dans-le-lait-malgre-linterdiction-du-e171