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PARTICLES, ADDITIVES AND CONTAMINANTS OF TATTOO INKS: ANALYTICAL CHALLENGES

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Tattoo inks are complex matrices composed of different substances and products that all add to the properties of the inks. In addition to the intentionally added substances and product are also contaminants contained in the ingredients of the ink. The fact that tattoo inks are not ideal solutions of pure compounds in a solvent but are rather a mixture of more or less miscible solids and liquids makes it a challenge to analyze in order to estimate the true composition of the inks. One of the problems is that analytical instruments usually require the mixtures to be studied in solution or that non-dissolved material can be separated from the dissolved. Another problem is that very polar or high molecular weight substances cannot be simultaneously analyzed with non-polar substances or substances of low molecular weight but often require a completely different instrument. The analytical challenges are similar to those encountered in analyzing surface modified nanoparticles for which we have developed a preliminary protocol. This protocol has been used to analyze the composition of organic compounds in 11 black tattoo inks (Høgsberg et al., 2013).

The ultrasonic extraction procedure for the tattoo inks was a modification of the method used by Regensburger et al. (2010). After methanol extraction the extracts were centrifuged at 20,000 g for 60 min in order to separate the carbon black pigment from the dissolved organics. One part of the supernatant was used directly for gas chromatography combined with mass spectrometry (GC-MS) analysis of lower molecular weight compounds and another part was used directly for matrix assisted laser desorption ionization mass spectrometry (MALDI-TOF-MS) to examine the content higher molecular weight, non-volatile, and polymeric compounds.

The extractable organic compounds from the investigated black tattoo inks showed a wide variety in types and concentrations. All organic compounds identified with MALDI-TOF-MS were non-ionic surfactants and included nonylphenol ethoxylates (Surfonic N-X), octylphenol ethoxylates (Triton X), heptylphenol propoxylates, alkenyl ethoxylates, mixture of polyethylene glycol, isosorbide oligomers and sorbitan ethoxylates (Tween), alcohol ethoxylates and 2,4,7,9-tetramethyl-5-decyne-4,7-diol ethoxylate (Surfynol 4XX). All the investigated tattoo inks consist of 2–3 main components in addition to the non-ionic surfactants and relatively high concentrations of PAH. The main components constitute 65–100% of the total extractable organic compounds analyzed with GC-MS and are all oxygenated compounds such as butanediol, glycerol and phenol.

Høgsberg T., Jacobsen N.R., Clausen P.A. and Serup J. (2013) Black tattoo inks induce reactive oxygen species production correlating with aggregation of pigment nanoparticles and product brand but not with the polycyclic aromatic hydrocarbon content. Experimental Dermatology 22, 464-469.

Regensburger J., Lehner K., Maisch T., Vasold R., Santarelli F., Engel E., Gollmer A., König B., Landthaler M. and Bäumler W. (2010) Tattoo inks contain polycyclic aromatic hydrocarbons that additionally generate deleterious singlet oxygen. Experimental Dermatology 19, e275-e281