

Mass Spectrometry in Identification of Color Components of Natural Organic Dyestuffs Used in Art

by **K. Lech, K. Poleć-Pawlak and M. Jarosz***

*Warsaw University of Technology, Faculty of Chemistry, Chair of Analytical Chemistry,
ul. Noakowskiego 3, 00-664 Warsaw, Poland*

Keywords: Cultural heritage; Mass spectrometry; Natural organic dyestuffs; Species identification; Sample preparation; Analysis of historical art objects

Color is one of the most important components of a historical work of art. Natural materials used for dyeing belong to few classes, three the most important among them are: mordant (*e.g.* weld, madder, cochineal), vat (*e.g.* indigo, Tyrian purple), and direct dyes (*e.g.* saffron, annato, turmeric). The most often used are mordant dyes – their shades appear thanks to the formation of complexes, which are constituted by the combination of dyestuff color components and metal ions. Identification of natural dyestuffs is an important target in the scientific examination of paintings, textiles, illuminated manuscripts, and colored printings or maps, as well as it plays an essential role in archaeometry, conservation, and restoration of works of art. Furthermore, it creates a serious challenge for analytical chemistry, since an amount of the sample is usually restricted to micrograms or even less. Most dyestuffs contain more than one coloring substancematter, and analytical methods used for their identification must include a separation step, performed mainly with the use of chromatography or related techniques. In the analysis of art objects, the most suitable detector is mass spectrometer (MS). The most typical ionization modes utilized in MS techniques are electron impact ionization (EI), classical chemical ionization (CI), atmospheric pressure chemical ionization (APCI), electrospray ionization (ESI), fast atom bombardment (FAB), and matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF-MS). The choice of proper instrumentation is limited by the properties of the analyzed samples and their preliminary chemical treatment.