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Secret of Leonardo da Vinci's smell-o-visions

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Paint analysis techniques could be used to analyse works such as *The Last Supper* ALAMY

Scientists knew they were close to discovering the “secret formula” used by Leonardo da Vinci for his paintings when they were greeted by the fresh smell of a forest after rain.

Tests conducted on *Donna Nuda*, a painting executed under Leonardo’s supervision that hangs at the Hermitage Museum in St Petersburg, have revealed a cocktail of ingredients that one researcher said was the artistic equivalent of finding the recipe for Coca-Cola.

It is the first time that a Leonardo has been analysed in such detail or with such fragrant results. Gleb Zilberstein, of the team who worked on the project, said it was a magical moment when he smelt odours that had been held beneath the surface of the painting for 400 years.

Analysis showed that the artist, who scholars believe was a protégé of Leonardo rather than the master himself, used a mixture of egg yolk, linseed oil and rosemary oil. They also detected a layer of conifer resin. Mr Zilberstein said that the formula could be used as a benchmark against which to test other paintings to determine their age and authenticity.

Martin Kemp, an authority on Leonardo and professor emeritus of history of art at Trinity College, Oxford, said the research had enormous potential.



Analysis of Donna Nuda, a work supervised by Leonardo da Vinci, has paint containing egg, linseed, rosemary and conifer ALAMY

Mr Zilberstein and his co-authors Elettra Barberis, Marcello Manfredi, Emilio Marengo and Svetlana Zilberstein are preparing to publish their research in the *Journal of Proteomics*. Their non-invasive technique involves placing acetate film embedded with charged particles on sections of the painting. The particles are analysed with gas and liquid mass spectrometry and chromatography to detect organic molecules.

The team previously used acetate film to find traces of morphine on Mikhail Bulgakov's manuscript of *The Master and Margarita* and evidence of tuberculosis in a blood spot on the shirt [worn by Anton Chekhov](#) as he died. They also identified traces of tuberculosis on a letter [sent by George Orwell](#) that indicated he was infected while recovering from a bullet wound during the Spanish Civil War.

Mr Zilberstein and his co-authors tested five parts of *Donna Nuda*, which is sometimes referred to as “the topless Mona Lisa”. Three of the parts contained traces of linseed oil and egg yolk, a substance known to artists as *tempera grassa*, while one section of landscape was found to contain rosemary oil.

“For the first time the deciphering of the recipes used by Leonardo was possible,” they wrote. “Insights on the artistic technique employed by the Renaissance master were revealed.”

They said rosemary oil allowed artists “to enhance the sense of depth” of the landscape and create a blur effect.

Previous attempts to analyse Leonardo’s materials have been limited. Pinin Brambilla Barcilon, who spent 20 years restoring Leonardo’s fresco *The Last Supper* in Milan, told the scientists that she had not been able to do a comprehensive analysis.

Researchers said that their technique could also be used to construct “a decay curve” of organic materials that would help to determine the date of a painting.

It will be up to owners of Leonardo paintings whether they subject them to testing. Christie’s undertook no scientific testing on *Salvator Mundi* before its [record-breaking sale](#) in 2017, when it fetched \$450 million (£341 million).

Asked whether he thought the owners of *Salvator Mundi*, officially the Abu Dhabi tourism authority, would let the work be tested if there were a danger of questioning its attribution, Professor Kemp said: “That’s always a risk. But owners always seem to think their work will come out smelling of roses.”

Doctoring history

- Mikhail Bulgakov’s manuscript for *The Master and Margarita*, a novel in which the Devil visits the Soviet Union, was found to have traces of morphine, which the author was using as a painkiller.
- Anton Chekhov’s shirt, worn by the writer on his deathbed, contained a blood spot that tested positive for tuberculosis. Proteins found in the blood indicated that he died from a sudden loss of blood to the brain.
- A letter from George Orwell to a Soviet journal editor held traces of tuberculosis. Although Orwell was known to have died of the disease, the sample suggested that it was a strain from the Spanish Civil War, which Orwell may have contracted in hospital while being treated for a bullet wound to his neck.
- Giacomo Casanova left traces of mercury on his memoir, which he is thought to have used to treat his venereal disease. However, no traces of syphilis were found, leading to speculation that he was either good at treating it or had received a misdiagnosis.