Investigating Archaeological food remains by Analytical Chemistry

The archaeology of food commodities is a wide field that includes the study of iconography, ceramic vessels, and various botanical and animal remains such as seeds and bones. Other remains, usually referred to as amorphous organic residues may also provide valuable information of food processed, stored or served
in ancient pottery. They are present as charred residues visible on the inner surface of ceramic vessels and amphorae but they can also correspond to non visible organic matter that has been absorbed into the porous clay matrix of the containers. They arise from a large variety of natural substances, namely subcutaneous animal fats, dairy products, vegetable oils, beeswax or honey, wine, etc.

The identification of such residues represents a real analytical challenge. Indeed, archaeological organic remnants are generally preserved in small amount and contain a wide variety of molecular constituents including lipids, terpenoid derivatives, proteins, polysaccharides and polyphenolds. They are made of complex molecular mixtures altered through time and are characterized by a large range of molecular weight distribution, including solvent-soluble volatile and non-volatile components, as well as, high-molecular weight polymers.
Due to their highly complex molecular composition and their degree of alteration, these remains must be studied using a multi-step methodology combining chromatographic and mass spectrometric analyses.

From recent prehistory (neolithic period) until Roman Antiquity, we will provide an overview of the results obtained on culinary recipes or commodities, including dairy products, honey stew, vegetable oils and resinated wine that could be identified owing to a set of molecular biomarkers and degradation markers such as fatty acids, triacylglycerols, sterols, long-chain esters and diterpenoid markers together with polyphenols. We will also emphasize on some alteration processes that occur in the sediment and that greatly alter the initial composition of the organic matter.

In conclusion, we will show that developing methodologies at the frontier between analytical chemistry and archaeology is a powerful way for enhancing our knowledge on the alteration of natural substances and on the exploitation and preparation of culinary commodities through time.

(adapted from the Abstract for plenary lecture at the XXth Italian Congress of Analytical Chemistry, Dr. Martine REGERT, Head of the Research Group ChimArt)

1 **Read the passage and summarise it.**

2 **What are the applications of analytical chemistry in modern life? Answer the question using all the information you have gathered so far.**

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The mystery of the discolored Van Gogh's

In some of the artist's works, the once-vibrant yellows are turning brown. European scientists have figured out why

It's hard to imagine some of Vincent van Gogh's signature works without the vibrant strokes of yellow that brightened the sky in "Starry Night" and drenched his sunflowers in color. But the yellow hues in some of his paintings have mysteriously turned to brown – and now a team of European scientists has figured out why.

Using sophisticated X-ray machines, they discovered the chemical reaction to blame – one never before observed in paint. Ironically, Van Gogh's decision to use a lighter shade of yellow paint mixed with white is responsible for the unintended darkening, according to a study published online Monday in the journal Analytical Chemistry.
"This is the kind of research that will allow art history to be rewritten," because the colors we observe today are not necessarily the colors the artist intended, said Francesca Casadio, a cultural heritage scientist at the Art Institute of Chicago.

In a number of Van Gogh's paintings, the yellow has dulled to coffee brown – and in about 10 cases, the discoloration is serious, said Koen Janssens, an analytical chemist at Antwerp University in Belgium who co-wrote the study.

The root of the problem is the lead-chromate paint he used. It was called chrome yellow, and it was part of a generation of paints that were then far brighter and more vibrant than the existing yellow ochre or orpiment shades.

Soon after their introduction in the 19th century, it became apparent that chrome yellow paint would degrade under sunlight.

Although conservators took pains to protect Van Gogh's paintings from the sun's ultraviolet rays, the gradual darkening continued. The discoloration proved unpredictable, afflicting the yellow in some works while sparing others.

What was causing Van Gogh's sunflowers to wither and the golden tone in his daylight scenes to dim? And why did the victims appear to be picked at random?

To find out, the researchers obtained three tubes of yellow paint from the Royal Museum of Fine Arts Antwerp that were manufactured around the same time that Van Gogh was working. They spread samples of the still-bright paint onto glass slides and bombarded them with ultraviolet radiation for three weeks to mimic the process of aging.

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Only one of the samples browned – and it did so in dramatic fashion, its color turning from daisy to coffee with milk. "It's amazing that the change was so quick and so profound," Janssens said.

To his frustration, though, the electron microscopy, infrared microscopy and other tests were of no help in understanding the reason for the brown layer. "Our eyes told us something had changed but all our equipment told us no change," Janssens said.

Finally, they hit the paint with a high-intensity X-ray at the European Synchrotron Radiation Facility in Grenoble, France. They discovered that that the colorfast samples were composed of chromium in its pure, crystalline form.

However, the paint that turned brown actually started out as a lighter shade of yellow than the other two tubes: The darkened sample contained sulfates, which are associated with white pigment. Those sulfates, Janssens said, had likely helped reduce the chromium's oxidation state from chromium-6 to chromium-3, taking on an increasingly greenish hue that contributed to the overall darkening.

The scientists ran the same tests on fresh paint made according to the 19th century recipe, as well as painting fragments from Van Gogh's lesser-known "Bank of the Seine" and "View of Arles with Irises." The team found chromium-3 in the samples that turned brown.

For now, there's no way to stop the darkening – only to slow it down. At a minimum, the researchers recommend keeping the paintings out of as much harmful light as possible.

by Amina Khan, Los Angeles Times, February 14, 2011
(taken from *www.latimes.com/news/science*)

1 **SCANNING - Read the article and try to catch its general meaning. Compare your guesses to your classmates'.**

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