

Assessing the Organoleptic Quality of "Pistacchio Verde di Bronte" Pastes Using GC-IMS

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CONTEXT

The consumption of pistachios (*Pistacia vera* L.) has increased globally in recent years due to their nutritional and health benefits, which are attributed to beneficial phytochemical compounds, high levels of polyunsaturated fatty acids, and low carbohydrate content. Pistachios are consumed in various forms, including raw, roasted, and as a paste/cream [1, 2]. This study explores the application of Gas Chromatography-Ion Mobility Spectrometry (GC-IMS) as a rapid and reliable technique to evaluate the organoleptic quality and identify potential defects in various "Pistacchio Verde di Bronte" (PDO) pastes. "Pistacchio Verde di Bronte" is a highly prized Italian product, and maintaining its characteristic flavor profile is crucial for consumer satisfaction and product authenticity. Traditional sensory evaluation can be time-consuming and subjective. Therefore, an objective analytical method is needed to complement sensory panels for quality control. Results indicate distinct VOC profiles for high-quality pistachio pastes compared to those exhibiting organoleptic defects. This suggests that GC-IMS can effectively discriminate between different quality grades and potentially identify the chemical basis of specific defects.

The aim: to demonstrate the significant potential of GC-IMS as rapid powerful tool for the objective assessment of pistachio paste quality. Its implementation could enhance quality control procedures, ensure product authenticity, and help maintain the high standards associated with this protected designation of origin.

MATERIALS & METHODS



Samples: five pistachio paste samples produced by using 100% "Pistacchio Verde di Bronte". Representative samples were selected that included pastes with and without defects reported by a group of panelists.

HS-GC-IMS: Headspace-gas chromatography-ion mobility spectrometry (HS-GC-IMS) (FlavourSpec®, G.A.S., Dortmund, Germany) was used to assess the volatile composition with an untargeted fingerprinting approach. A 20 mL glass vial was filled with 2.0 g of the sample. Then samples were treated for 5 minutes at 50 °C at 500 rpm. Then, in splitless mode, a 300 µL headspace sample was automatically delivered through a 70 °C heated syringe. Using an MXT-5 column (15 m × 0.53 mm i.d., 1 µm film thickness; Restek Corporation, Bellefonte, PA, USA), the volatile chemicals were separated at 40 °C. As the carrier gas, 99.999 percent pure nitrogen was employed, and the flow rate program was configured as follows: 2 mL/min for 2 minutes, followed by a 5-minute rise to 150 mL/min and a 3-minute hold with an analytical run time of 10 minutes. A 3H ionization source ionized the eluted analytes before driving them to a drift tube, which was run at a constant temperature of 45 °C and voltage of 5 kV.



RESULTS AND DISCUSSION

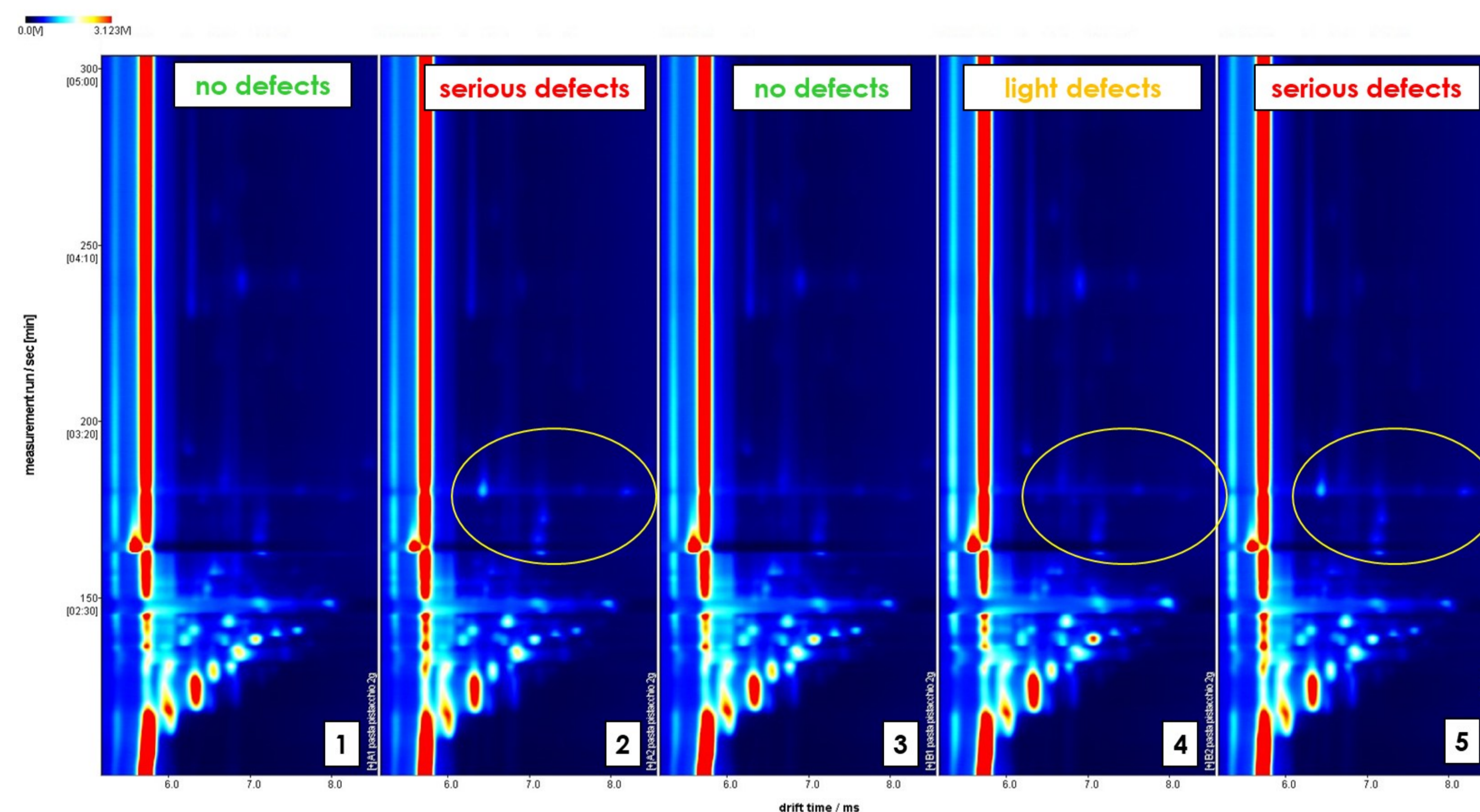


Figure 1. Topographic map of the five pistachio paste samples.

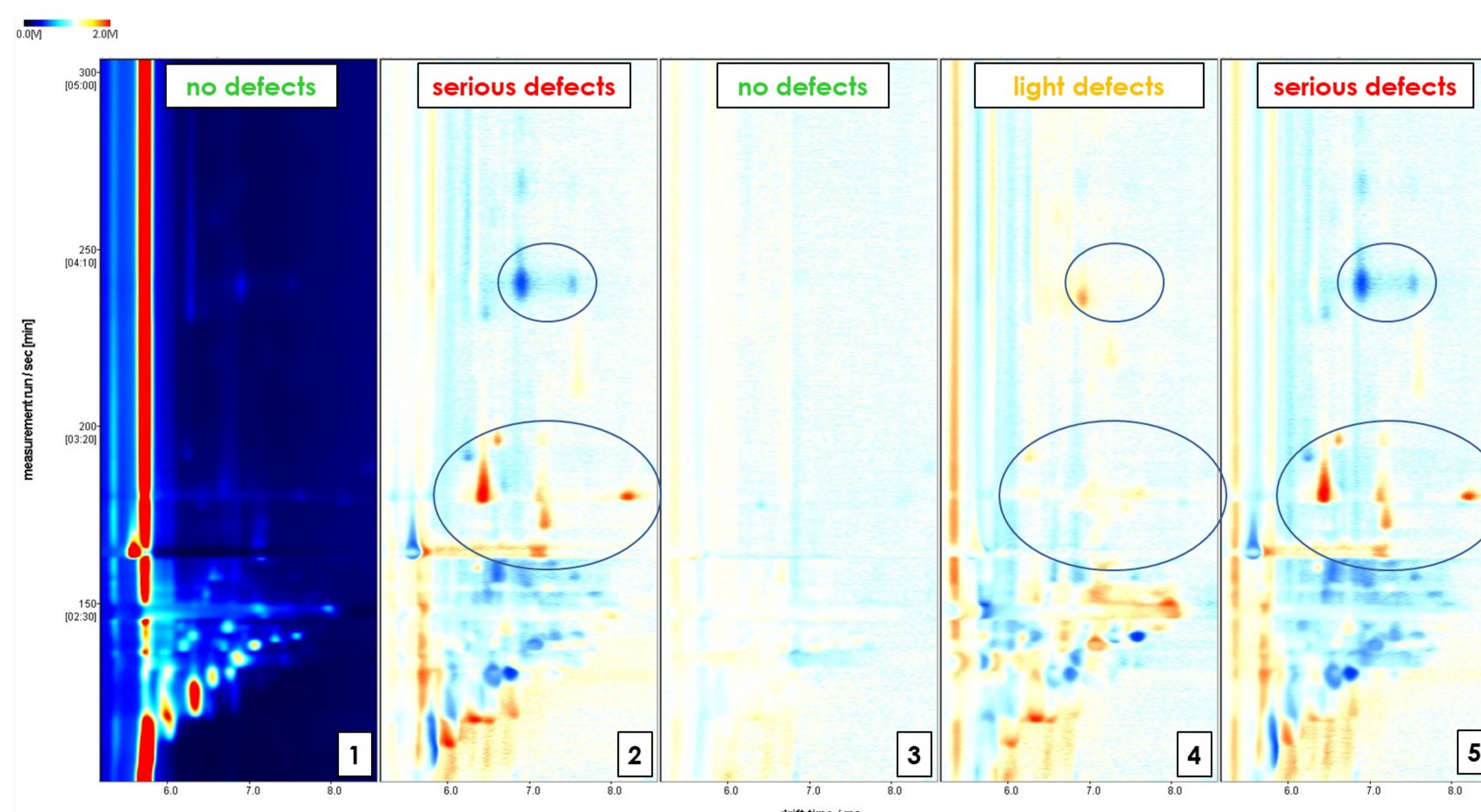


Figure 2. Comparative non-targeted 2-D maps of the differences between the five paste samples analysed.

HS-GC-IMS was used to analyze the VOCs in pistachio paste samples. A 2D top view of the VOCs in the five paste samples was plotted using the Reporter plug-in (Figure 1), enabling a detailed comparison of the differences in VOCs between the different samples.

The vertical coordinate indicates the retention time of the GC, and the horizontal coordinate indicates the drift time and the reactive ion peak (RIP). The different-colored points on either side of the RIP represent the different VOCs detected.

As can be seen from Figure 1, most of the signal occurred at retention times of 80-200 s and drift times of 6.0-8.0 ms.

And the difference in color on either side of the peak elucidates the signal intensity of the different volatiles detected in each paste sample. The red signal indicates a higher concentration of the detected volatiles, and the darker the color, the higher the intensity, indicating a higher concentration of that volatile substance. The white color indicates lower concentrations of the detected volatiles.

With this layout, it is often difficult to highlight differences between samples. For this reason, a differential contrast model was used to compare the differences between samples, using the 1 (no defects) sample as the reference contrast and the remaining sample minus the reference. If the two VOCs agree, the background after subtraction is white; if it is red, it means that the substance concentration is higher than the reference, and blue means it is lower than the reference. In the differential contrast model plot (Figure 2), the concentrations of the volatile substances can be seen. As can be seen in figure, there were some characteristic differences in the volatiles in the samples resulting with light or serious defects when compared with defect-free samples.

For example, it is interesting to note how the samples with serious defects in the panelists' test show a significantly higher intensity for some volatile compounds detected in the 150-200 s zone (referring to retention time). The discrepancies detected in the sample with light defects were significantly smaller than those with serious defects.

CONCLUSIONS

This non-targeted rapid analytical approach is not intended to replace panel testing but should instead be considered a support tool capable of making sample evaluation more robust, assessing their quality and potentially identifying non-compliant samples.

References

[1] Mateos, R., Salvador, M. D., Fregapane, G., & Goya, L. (2022). Why Should Pistachio Be a Regular Food in Our Diet? *Nutrients*, 14(15), Article 15.

[2] Pedron, G., Jaouhari, Y., & Bordiga, M. (2025). Conventional and Innovative Drying/Roasting Technologies: Effect on Bioactive and Sensorial Profiles in Nuts and Nut-Based Products. *Applied Sciences*, 15(3), Article 3.

