

Examining the Alterations in Lipid, Protein, and Flavour Profiles During Pistachio Paste Processing

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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 cream (Mateos et al., 2022). For these reasons, the evaluation of several industrial process parameters with innovative assays has become crucial to guarantee the preservation of nutritional properties, taste, colour, flavour, and several other characteristics (Pedron et al., 2025).

The aim of this project

Is to improve the sensory quality of pistachio paste, this study examined the changes in protein, fatty acid, and volatile flavor profiles induced by roasting and milling, relative to raw pistachios, in three distinct varieties from different geographical origins especially USA (U), Europa (S), Turkey (T). Samples were provided by UNIGRA S.p.A.

MATERIALS & METHODS

To comprehensively evaluate process quality, a multi-faceted analytical approach was employed. This included gas chromatography-ion mobility spectrometry (GC-IMS) provided by G.A.S. Dortmund, gas chromatography-mass spectrometry (GC-MS) for oxidation marker quantification, colorimetric assays, spectrophotometric assays for chlorophyll and β -carotene content, and sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE) for protein determination. The high oil content of pistachios necessitated further analysis of the oil, extracted via Soxhlet apparatus with dichloromethane, to determine its fatty acid methyl ester (FAMES) and triglyceride profiles.



Fig. 1 Sample of raw and relative paste of pistachios.

RESULTS

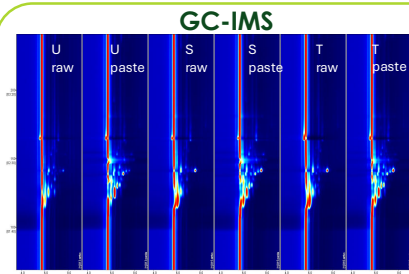


Fig. 2 Aroma and flavor profile evolution of raw and paste of pistachios analyzed by GC-IMS.

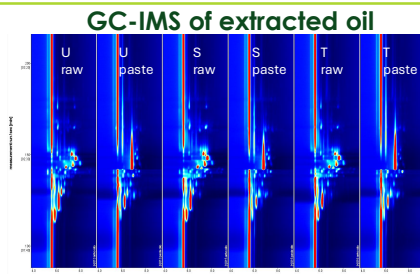


Fig. 3 Evolution of volatile aroma and flavor profiles in pistachio oil extracted from raw and paste samples, analyzed by GC-IMS.

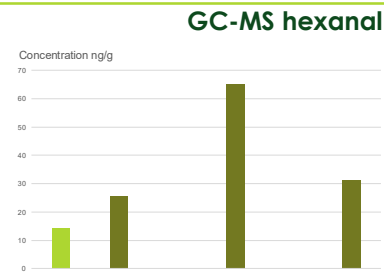


Fig. 4 The evolution of exanal concentration, serving as an indicator of lipid oxidation, was tracked throughout the roasting and pasta-making processes. Quantification was achieved using a calibration curve ($R^2 = 0.98$) generated from four standards with concentrations spanning 0.1 ng/g to 100 ng/g.

Colorimetric assay

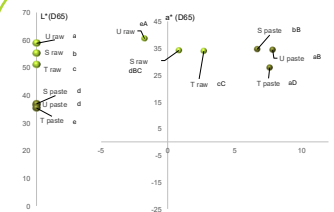
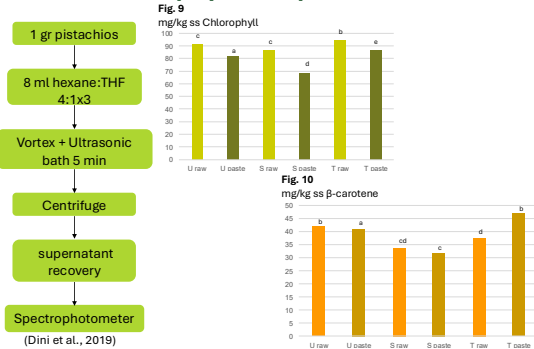


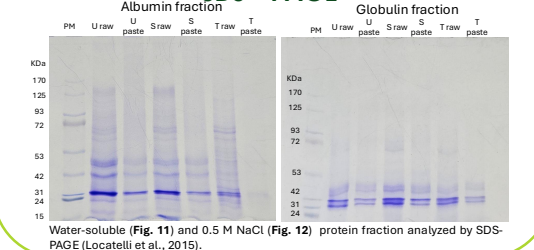
Fig. 5 Colorimetric assay performed using a Konica Minolta CM-5 spectrophotometer. Statistical significance in a* (D65) values is denoted by lowercase, while uppercase indicate significant differences in b* (D65) values between samples.

Chlorophyll and β -carotene



Quantification of total chlorophyll (Fig. 9) and β -carotene (Fig. 10) using spectrophotometry assay (Dini et al., 2019).

SDS - PAGE



Water-soluble (Fig. 11) and 0.5 M NaCl (Fig. 12) protein fraction analyzed by SDS-PAGE (Locatelli et al., 2015).

Principal Triglycerides

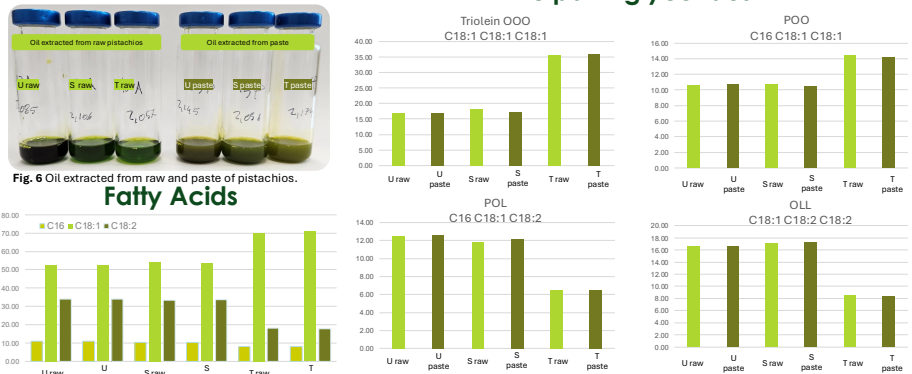


Fig. 7 Relative percentages of fatty acids determined by GC-FID following FAME derivatization (Locatelli et al., 2015). C16: Palmitic acid; C18:1: Oleic acid; C18:2: Linoleic acid.

Fig. 8 Relative percentages of principal triglycerides determined by HPLC-RID. P: palmitic acid (C16); O: oleic acid (C18:1); L: linoleic acid (C18:2).

DISCUSSION & CONCLUSION

In summary, roasting significantly alters the chemical and physical properties of pistachio nuts. During pistachio paste production, GC-IMS analysis identified the release of several volatile organic compounds, as illustrated in (Fig. 2). Figure 3 revealing a distinct volatile fingerprint of the oil. Notably, hexanal levels, exhibited a slight increase during paste processing (Fig. 4). Analysis of the extracted oil initially revealed compositional variations based on geographical origin. However, no significant differences in oil composition were detected between raw pistachios and the resulting paste.

Finally, SDS-PAGE analysis (Fig. 11 and 12) demonstrated a degradation of the protein profile upon paste making. Concurrently, visual color shifted from light green to brownish-green with reduced lightness (Fig. 5), consistent with a decrease in total chlorophyll content (Fig. 9) during processing. Interestingly, β -carotene levels generally decreased, with the exception of sample T, where an increase was observed.

Reference

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