

Measuring Spice Freshness & Antioxidant Capacity with the ESR5000

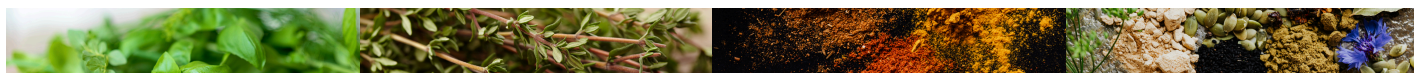
A Faster Way to Understand Shelf Life

Spices and natural food colorings gradually degrade as oxidation builds up, leading to flavor loss, fading color, and reduced shelf life. Traditional shelf-life testing relies on long storage studies or indirect chemical methods, which can be slow and subjective.

Electron Spin Resonance (ESR) with the ESR5000 spectrometer offers a faster, more direct approach. By detecting free radicals formed during oxidation, ESR allows food scientists to evaluate oxidative damage and antioxidant performance in dried spices, seasonings, and natural colorants in minutes rather than months.



The ESR5000
Benchtop ESR-EPR Spectrometer



What ESR Measures

As products age, oxidation creates free radicals—molecules with unpaired electrons. ESR directly measures these radicals, producing a signal that reflects the true oxidative age of a sample.

Higher ESR signal indicates greater oxidative damage and reduced freshness, while lower signal levels indicate better preservation and stability.

Workflow Overview

Dried samples are placed directly into a standard 5 mm ESR tube with no chemical extraction or modification required. The ESR5000 spectrometer then measures free radical signals using predefined settings optimized for seasonings and colorants, delivering rapid, reproducible insight into oxidation and shelf-life behavior.

Measuring Antioxidant Capacity

Beyond assessing freshness, ESR can evaluate how well spices resist oxidation. Samples are heated to accelerate oxidation, and ESR measurements track how quickly free radicals form over time.

A rapid increase in signal indicates weaker antioxidant protection, while minimal change reflects stronger resistance to oxidative stress. This allows direct comparison of antioxidant performance across products, batches, or formulations.

Applicable Samples

This method is well suited for dry seasoning powders and small particulates (under 5 mm), including spices such as basil, oregano, turmeric, cinnamon, and plant-based colorings like paprika or annatto. High-moisture samples, such as fresh herbs, may require additional preparation.



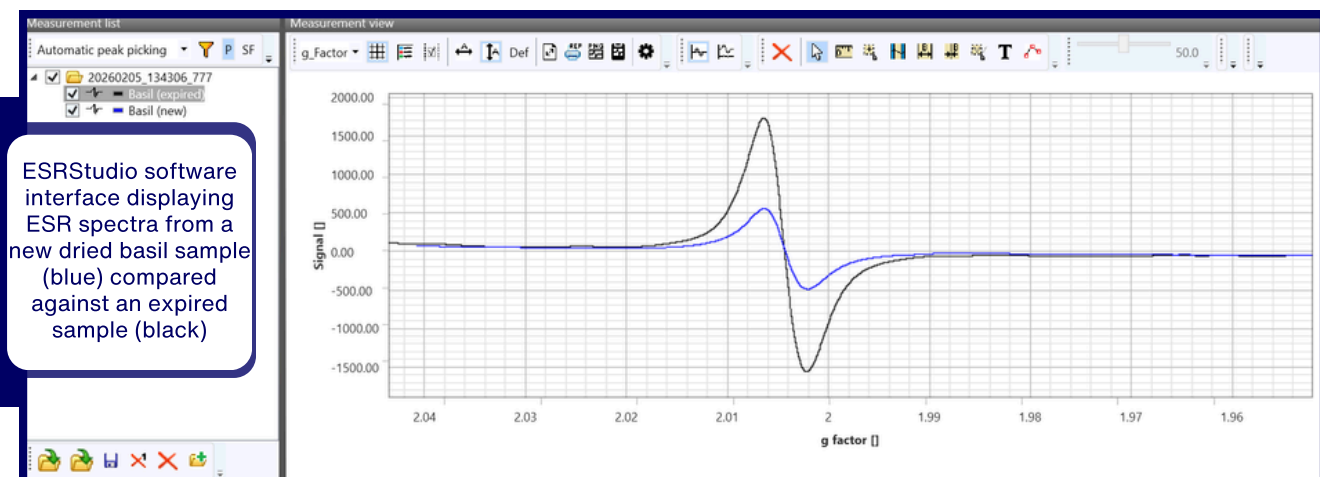
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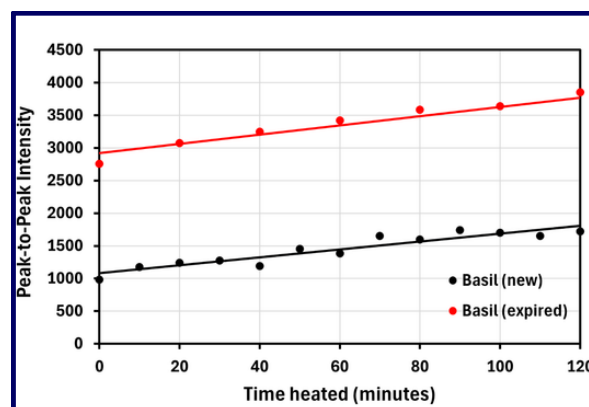


ESR Data Analysis Using ESRStudio

The ESR5000 uses ESRStudio software, which provides rapid visualization and quantitative evaluation of free radical signals. During acquisition, users can view ESR spectra in real time, while automated baseline correction and signal normalization ensure consistent, reliable data. The software quantifies peak intensity and signal area and allows direct comparison between fresh and aged samples, as well as across different batches or formulations. Together, these capabilities enable quick assessment of oxidative state and antioxidant performance without the need for complex post-processing or external data analysis tools.

Example: Fresh vs. Expired Basil

The ESR data to the right were collected from new and expired basil samples heated at 80 °C to accelerate oxidation. As heating time increases, peak-to-peak intensity rises for both samples, reflecting progressive free radical formation and declining antioxidant protection. Across repeated measurements, expired samples consistently exhibit higher ESR signals than freshly purchased samples, indicating reduced antioxidant capacity and greater oxidative damage during thermal exposure.



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