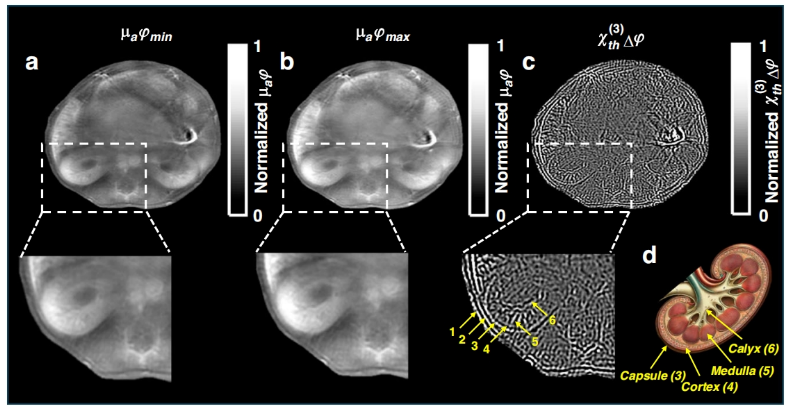
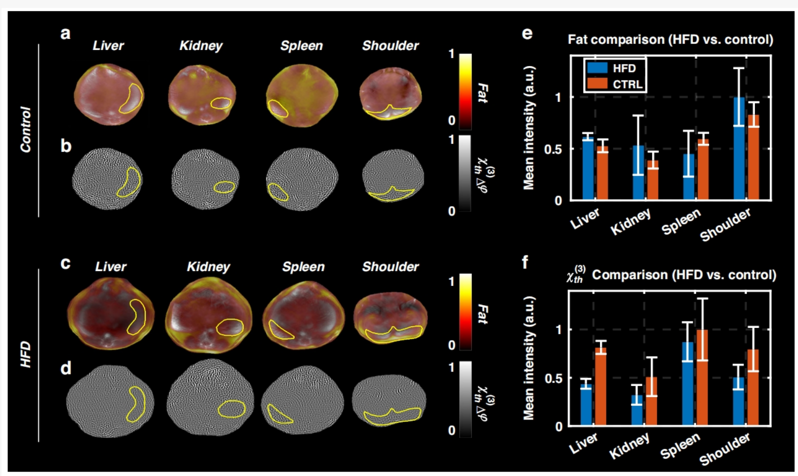
Nonlinearity of optoacoustic signals and a new contrast mechanism for imaging.

FAYETTEVILLE, GA, UNITED STATES, April 16, 2025 /EINPresswire.com/ -- Researchers have unveiled a novel imaging method that leverages the interaction between light, sound, and thermally induced changes in materials. This discovery identifies a previously unexplored contrast mechanism in [optoacoustic imaging](), which arises from small temperature-driven variations in electromagnetic properties. The new approach enhances imaging sensitivity and resolution, enabling precise visualization of tissue structures. This advancement holds significant promise for improving diagnostic accuracy and advancing biomedical applications, particularly in tissue characterization and disease monitoring.



Optoacoustic imaging taken in-vivo through a mouse kidney cross-section.



Optoacoustic and thermally excited third-order nonlinear susceptibility (TETONS) imaging data acquired in vivo for mice fed a high fat diet (HFD) or control (CTRL) diet.

Optoacoustic imaging has emerged as a powerful technique for visualizing biological tissues with high resolution and contrast. In a new study published in Light: Science & Applications, a team of scientists led by Jaber Malekzadeh-Najafabadi and Vasilis Ntziachristos explored the origins and applications of nonlinear changes in optoacoustic tomography at low light fluence.

The team identified that changes in electromagnetic permittivity, induced by thermally excited third-order nonlinear susceptibility, significantly contribute to optoacoustic signal nonlinearity at low light fluences. Using theoretical models and experimental validations, the researchers demonstrated that nonlinear variations are most prominent at high-frequency optoacoustic signals and can be harnessed as a novel imaging contrast mechanism.

The findings open the door to new imaging methodologies that improve the accuracy of tissue characterization. By mapping thermally excited nonlinear susceptibility, the researchers reconstructed the first images showcasing this unique contrast in phantoms and in vivo mouse tissues. The method also displayed potential for monitoring physiological and pathological changes in organs such as the kidney and liver, offering insights into diseases linked to tissue composition changes, including obesity and metabolic disorders.

"We were fundamentally interested in better understanding the source of non-linearity observed in optoacoustic signals" says Ntziachristos. "Our findings underscore the potential of using the non-linearity of the optoacoustic signal to offer a revolutionary new contrast mechanism in optoacoustic imaging," adds Malekzadeh-Najafabadi. "While further studies are required to corroborate our postulation on the sources of non-linearity, the new method can be widely employed in basic research and clinical translation applications" adds Ntziachristos.

References
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