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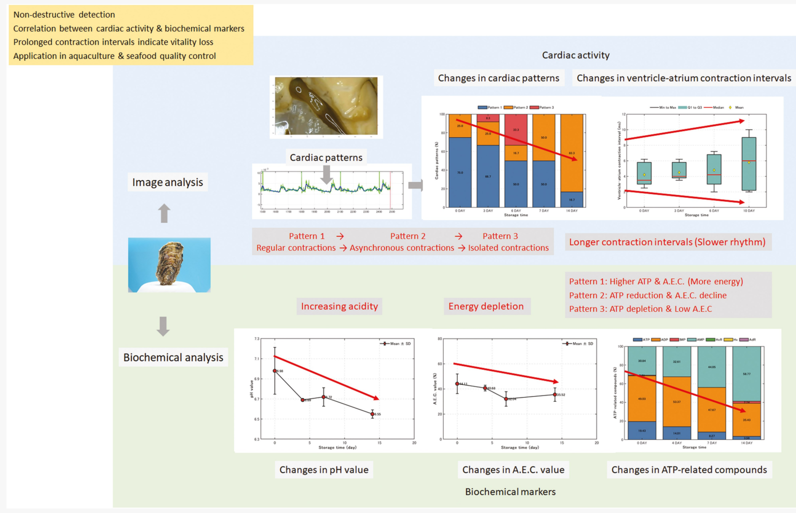
Heartbeat imaging offers new insight into oyster freshness



Integrated Image and Biochemical Analysis for Oyster Vitality Assessment.

GA, UNITED STATES, July 19, 2025 /EINPresswire.com/ -- Monitoring the vitality of shellfish during cold storage is critical for ensuring seafood quality, yet conventional methods remain invasive, subjective, and slow. In a new study, researchers unveil a groundbreaking, non-destructive technique to assess oyster health by analyzing heartbeat patterns through high-resolution image processing. By monitoring cardiac activity and biochemical markers such as adenosine triphosphate (ATP) levels and pH in Pacific oysters over 14 days of refrigerated storage, the team uncovered distinct cardiac signatures that closely tracked vitality loss. These findings suggest that visualizing heart rhythms offers a sensitive, real-time tool for detecting physiological decline—providing a practical, scalable solution for seafood quality assurance.

Pacific oysters are a cornerstone of global aquaculture, but assessing their health after harvest is notoriously difficult due to their tightly closed shells. Traditional vitality checks often require forcibly opening shells, which is labor-intensive, invasive, and prone to error. Though technologies like near-infrared spectroscopy and magnetic resonance imaging offer promise, their high costs and operational complexity limit widespread use. Existing biochemical methods, while valuable, rely on destructive sampling and fail to provide immediate results. Based on these challenges, there is a pressing need for a faster, non-invasive, and cost-effective solution to monitor oyster health during storage and transportation. This study sets out to address that gap.

Now, a collaborative team from Iwate University, Zhejiang University, and the University of Auckland has introduced a novel method for vitality assessment in oysters, using image-based heartbeat tracking. Published (DOI: 10.1093/fqsafe/fyaf020) in Food Quality and Safety on May 20, 2025, the study showcases how this non-invasive technique can monitor subtle physiological changes over time. By pairing cardiac imaging with biochemical analysis, the researchers propose a robust tool for quality control in aquaculture—one that bypasses the limitations of current practices and opens the door to large-scale adoption.

In their experiment, oysters were stored at -1°C and assessed over two weeks using video imaging to analyze heart activity, while simultaneously tracking ATP compounds, pH levels, and adenylate energy charge (A.E.C.). The team identified five cardiac patterns, from normal rhythmic contractions to complete arrest, corresponding to different vitality stages. A key marker was the contraction interval between atrium and ventricle, which extended from 4.2 to 5.6 seconds during storage—closely paralleling a drop in A.E.C. from 44.1% to 35.5%. The method also captured the disappearance of intermediate cardiac patterns around day seven, indicating progressive decline. Unlike traditional sampling, this approach provided real-time, contact-free assessments. While amplitude readings were affected by optical noise, waveform patterns remained reliable. A radar chart integrating multiple metrics confirmed strong alignment between cardiac rhythm and vitality loss, reinforcing the method's potential as a powerful diagnostic tool for the seafood industry.

"Our goal was to create a simple, non-invasive technique that could be used in real-world seafood logistics," said Dr. Xin Lu, corresponding author of the study. "Cardiac pattern analysis through image processing proved both accurate and scalable. It allows for vitality assessment without opening the shell or using expensive instruments, making it a promising tool for large-scale commercial operations."

The implications of this multi-indicator approach extend far beyond oyster storage. By enabling continuous, real-time monitoring without harming the organism, this technique can help farmers optimize harvest timing, minimize spoilage, and preserve freshness throughout the supply chain. Its adaptability to automated systems could improve food safety standards and build consumer confidence. Moreover, the method could be extended to other aquatic species, advancing sustainable and data-driven practices in aquaculture. Future research will focus on enhancing imaging accuracy and expanding the tool's application to diverse storage conditions and longer preservation periods.

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