



Lever VC Insights

The Five Most Disruptive Technologies for the Fermentation Industry

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Technologies to Advance Precision and Biomass Fermentation for Food Products and Ingredients (April 2024)

Precision and biomass fermentation are versatile approaches that aim not only to enhance existing products but also to discover entirely new ones by harnessing the power of modern bioengineering, and learning powerful lessons from nature's diverse capabilities. While significant strides have been made, including breakthroughs in CRISPR gene editing, AI/ML-bioinformatics systems, and high-throughput screening technologies, challenges persist, such as scaling up biological processes and reducing costs. This is why emerging bio-based producers are carving a niche in high-value markets like flavorings and specialty nutraceuticals, capitalizing on biological processes' ability to sidestep conventional production while maintaining price parity.

To achieve a broader transformative impact on food systems, price parity with conventional counterparts and consistent quality are necessary. Lever VC identifies several technologies poised to reshape the fermentation landscape, offering potential solutions to existing barriers.

1. Organism strain development with potential for >10x productivity improvement

Precision and biomass fermentation economics are limited by the productivity of the microorganisms, with enhancing titers, optimizing feedstock utilization, and managing biomass densities being crucial parameters. Various strategies have emerged to optimize the organism, ranging from rational design utilizing AI/ML-trained algorithms to high-throughput irrational approaches, showing promise for major step-change improvements in productivity. Particularly newly developed strains often lack ready-to-go processes and require adaptation to effectively operate at a commercial scale.

2. Continuous fermentation for enhanced bioproduction

Continuous fermentation is widely recognized as a pivotal element in advancing the bioeconomy and has been a focus of research within the pharmaceutical industry for decades. Despite this, large-scale implementation of continuous fermentation remains elusive, primarily due to challenges related to contamination and genetic drift. Companies developing robust, generalizable continuous fermentation solutions that can slot into existing capacity stand poised to revolutionize the landscape. CAPEX costs are significant considerations in converting commercial fed-batch assets to continuous systems. Thus, the trade-off between adapted hardware and new fermenter designs needs to be considered when analyzing continuous fermentation systems.

3. Improved and lower-cost downstream processing equipment

Downstream processing often constitutes nearly half of the total cost involved in final product manufacturing. Within this realm, two pivotal processes significantly impact production expenses: chromatography and drying. Chromatography, initially designed for pharmaceuticals, utilizes expensive consumables and enables high-purity separation. However, for most food applications, purity requirements are much different than those for pharmaceuticals. Meanwhile, existing drying techniques like spray drying or freeze drying are notorious for their high energy consumption and potential to compromise nutritional quality, whereas drum drying yields inferior outcomes. The emergence of novel technologies capable of supplanting these industry standards holds the potential to revolutionize the entire fermentation sector.

4. Standardization of industry waste streams for fermentation growth media

Numerous companies in the biomass and precision fermentation sectors intend to utilize industry-side streams to lower feedstock costs. However, transitioning to side or waste stream-based feedstocks presents challenges due to their inconsistent chemical composition, which can vary by season and source. Companies striving to optimize and stabilize waste streams without inflating costs could unlock this opportunity for many firms.

5. Data-driven technologies to identify and trace changes in sensory characteristics of products throughout the production process



As extensively documented, taste and sensory appeal pose significant hurdles for alternative proteins, including those derived from fermentation, which may carry undesirable flavors depending on processing methods. A major challenge lies in pinpointing which parameters in the bioprocess influence the final product. Technologies such as eNose sensors or other volatile analysis tools capable of gathering data and identifying flavor improvement opportunities, particularly in biomass fermentation processes, will streamline product formulation and yield cleaner-label, consistent products. Additionally, statistical and AI-assisted algorithms that can correlate changes in bioprocess parameters with changes in sensory parameters can be incredibly helpful in optimizing for sensory experiences.