



# PRESERVING COFFEE'S COMPLEXITY

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How Cold Extraction Enables Functional  
Beverage Innovation



# Coffee as a functional ingredient

Coffee is celebrated worldwide for its distinctive aroma, flavor, and sensory complexity.

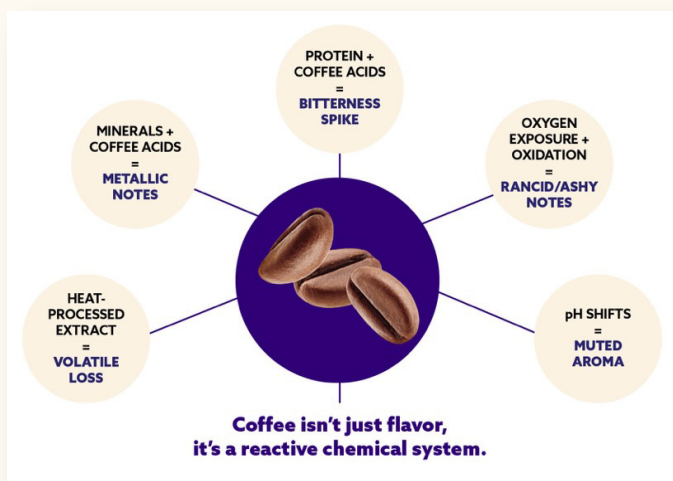
For food and beverage professionals, however, replicating this experience in functional or multi-ingredient formulations is challenging. Traditional extracts, concentrates, and flavors often fall short, delivering only a portion of coffee's true character.

Cold extraction provides a solution: a clean, versatile base that preserves coffee's authentic profile while supporting the formulation of products ranging from protein beverages to baked goods. This white paper explores the science behind coffee's complexity, the impact of heat on its chemical integrity, and how proprietary cold-water extraction enables consistent, functional applications at scale.

## Understanding Coffee's Chemical System

Coffee's sensory appeal is defined by a highly complex chemical fingerprint, composed of both volatile and nonvolatile compounds. Key contributors include:

- Oils – from crema, retain aroma, and influence mouthfeel.
- Caffeine – contributes bitterness, body, and stimulating effects.
- Organic acids – provide brightness and balance.
- Proteins and amino acids – react with carbohydrates during roasting (Maillard reaction) to create melanoidins, impacting color, texture, and sensory depth.
- Volatile compounds – over 1,000 have been identified in roasted coffee, with 20-30 dominating aroma and flavor.





When coffee is used as an ingredient rather than a finished beverage, these compounds interact with proteins, sweeteners, minerals, and functional actives. Minor changes in pH, temperature, or ingredient load can significantly alter flavor release, bitterness perception, and overall balance.



### Adam Faiq

Director of Product Development  
Vibrant Ingredients

"When coffee is used as a base for functional beverages, the question shifts from 'Does it taste like coffee?' to 'How does coffee behave within a complex formulation?' That distinction is where many products succeed or fail."

## How Coffee Interacts with Multi-Ingredient Formulations

**Coffee's chemistry becomes even more dynamic in the presence of functional ingredients.** Proteins, electrolytes, vitamins, and botanicals can interact with coffee's acids, oils, and volatiles in ways that amplify or disrupt sensory performance.



"Coffee is often underestimated as an ingredient," says Faiq. "Its chemistry is highly reactive, and once proteins, minerals, or functional actives are introduced, formulators are managing a dynamic system. Preserving balance requires a deep understanding of both coffee chemistry and formulation science."

Without careful control, these interactions can lead to bitterness, muted aroma, or instability, limiting coffee's effectiveness as a functional base.



# Thermal Stress and Coffee Stability

Understanding coffee's chemical complexity is essential, but how that chemistry is handled during processing ultimately determines whether those attributes are retained or lost. Heat is essential during roasting to develop coffee's characteristic aroma and flavor. However, excessive or uncontrolled heat during brewing, concentration, or formulation can destabilize its chemical profile. Exposure to high temperatures and oxygen accelerates oxidation, leading to undesirable flavors such as rancid, bitter, or ashy notes.

Many commercial coffee extracts and concentrates rely on hot-brew processes, which often compromise sensory integrity. Even moderate heat, above 160°, can generate off flavors, limiting their suitability for complex formulations.

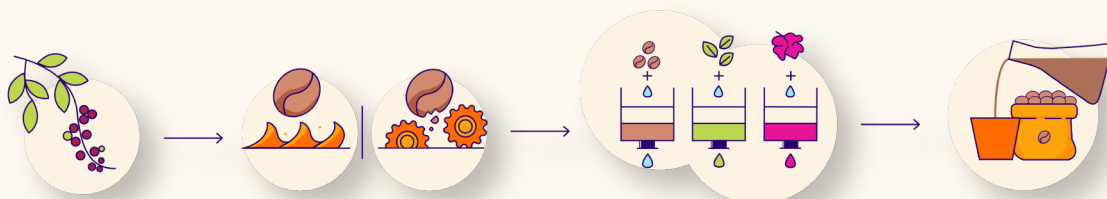
## Implications for formulators:

- Heat-sensitive compounds must be preserved to maintain balance in multi-ingredient systems.
- Oxidative changes impact both flavor and functional performance.

As Faiq notes, "Coffee is a highly reactive system. Heat, oxygen, and even small changes in processing conditions can dramatically shift the balance of flavor compounds. Understanding these sensitivities is essential to maintaining sensory integrity in complex applications."

## Cold Extraction: Preserving Ingredient Integrity

Reducing thermal stress during processing is a critical factor in maintaining coffee's sensory and functional integrity. Vibrant Ingredients' cold-water extraction process addresses these challenges. By avoiding heat, the **patented method** retains the full spectrum of coffee's volatile and nonvolatile compounds, preserving aroma, flavor, and mouthfeel.





"Cold extraction preserves both volatile and nonvolatile compounds, which is critical when formulating complex beverages. These compounds interact with proteins, acids, and functional actives in ways that can enhance or disrupt flavor and functionality, making preservation at every step essential. By maintaining coffee's original chemical balance, cold extraction enables more predictable performance in functional systems."

**Adam Faiq**

Director of Product Development  
Vibrant Ingredients

## Protecting Coffee Chemistry Through Cold-Chain Handling

Beyond extraction, cold-chain handling further protects coffee from acidification and thermal degradation ensuring that extracts and concentrates maintain sensory integrity throughout shelf life. This approach enables coffee to function reliably as both a flavor foundation and a carrier for functional ingredients.

### Benefits for formulation:

- **Maintains volatile and nonvolatile compounds critical to flavor and functionality.**
- **Supports the integration of proteins, vitamins, botanicals, and other actives without compromising sensory quality.**
- **Provides a scalable, consistent base suitable for beverages, confections, and other applications.**

## Preserving Performance Through Single-Pass Extraction

Concentration introduces another layer of complexity. In many systems, achieving higher strengths requires secondary concentration steps that rely on added heat and extended processing time, both of which can compromise coffee's chemical integrity.





Our process naturally yields a concentrate through a single-pass brew, eliminating the need for downstream concentration. By avoiding secondary thermal steps, we preserve the full spectrum of volatile and nonvolatile compounds while achieving strengths ranging from 3X to 28X. The result is a clean ingredient statement consisting of only roasted coffee and purified water, with no trade-offs in quality or functionality.

"Concentration is more than simply removing water," says Faiq. "It is about protecting the integrity of coffee's complex chemistry. Preserving both volatile and nonvolatile compounds is critical for sensory quality and for supporting functional benefits in finished products."

## Scalability and Consistency in Commercial Applications

For foodservice operators, consistency and operational efficiency are just as critical as flavor performance. Concentrated coffee extracts offer practical advantages that address real-world operational challenges, particularly in high-volume and drive-thru environments where speed of service directly impacts customer satisfaction and revenue.

Chris Johnson, President of Foodservice, notes, "Concentrated coffee extracts provide operators with consistency, scalability, and flexibility. They reduce labor, speed workflows, and help ensure product availability, all while maintaining the sensory integrity customers expect." Faster workflows are essential for minimizing wait times, improving order throughput, and delivering a positive guest experience. By enabling quicker preparation and service, concentrates allow operators to process more orders in less time. This helps maximize revenue potential while supporting consistent quality across locations.

### Operational benefits include:

- **Pumpable, easy-to-use formats for precise portion and flavor control**
- **Reduced labor compared to traditional cold brew preparation**
- **Faster service that supports drive-thru efficiency and higher order throughput**
- **Improved inventory management and reduced risk of outages**
- **Lower shipping volume and water transport costs**



# Beyond Coffee: Tea and Botanicals

The principles of cold extracts extend beyond coffee to tea and other botanicals.



Preserving both sensory and functional compounds enables formulators to create clean label products aligned with consumer interest in wellness and self-care.

By providing a stable, versatile base, cold-extracted ingredients allow formulators to deliver products that excel in flavor, stability, and functional performance across diverse applications.

## Building Reliable Functional Foundations with Cold Brew Coffee

Cold extraction transforms coffee from a challenging ingredient into a reliable foundation for functional formulations. By preserving its full chemical and sensory complexity, cold-extracts coffee formulators to:

- Maintain authentic coffee flavor in multi-ingredient systems
- Integrate functional actives without compromising sensory quality
- Scale efficiently across a range of applications, from beverages to baked goods

In a market where consumers expect both taste and functional benefits, cold extraction ensures coffee and other botanical ingredients deliver on both.

