Micellar Casein Concentrate

Milk is a rich source of nutrients, allowing it to be fractionated into a wide range of ingredients that can boost the nutritional quality of foods and beverages. One of those ingredients is micellar casein concentrate (MCC), which is isolated from milk through filtration. MCC has a unique protein profile and rare set of functional benefits that make it a valuable ingredient for manufacturers. Functional benefits include wetting, dispersibility, heat stability at a neutral pH and solubility.

What is MCC?

Cow's milk contains approximately 3.6% protein, and 80% of that protein comes from casein micelles. Casein micelles contain fractions of casein linked by calcium and phosphorus. At a neutral pH, they have a negative charge that stabilizes them against coagulation and maintains the solubility of casein, calcium and phosphorus. Casein micelles are substantially larger than other nonfat milk components. This allows them to be physically isolated through filtration. In addition, because MCC is an emerging ingredient, it does not have a standard of identity in the United States.

How is MCC produced?

MCC is produced through microfiltration, a process that allows whey protein, lactose and soluble minerals to pass through the membrane while retaining the larger-sized micellar casein. The purity can vary from the 80:20 ratio of casein to total protein found in milk to the 95:5 ratio found in highly purified MCC. Typical micellar casein has a ratio of at least 92:8.

FIGURE 1: COMPOSITION OF MICELLAR CASEIN COMPARED WITH OTHER DAIRY PROTEIN POWDERS (IN %)

	MCC	MPC	ACID CASEIN	CALCIUM CASEINATE	SODIUM CASEINATE
Protein	83.0	82.5	92.0	88.0	92.7
Lactose	1.0	2.5	0.5	0.7	0.3
Fat	1.0	1.0	1.0	2.0	0.7
Ash	7.8	6.6	2.4	5.0	3.0
Calcium	2.3	2.1	0.03	0.85	0.03
Phosphorus	1.7	1.6	1.25	1.1	1.23
Sodium	<0.05	<0.05	<0.05	<0.05	1.12
Moisture	5.0	5.0	10.0	5.0	4.3

What are the functional and sensory benefits of MCC?

The functionality of MCC is similar to that of milk protein concentrate (MPC). However, with the majority of whey proteins removed, MCC is a unique dairy protein with heat stability above approximately 80°C. This heat stability allows MCC to be further concentrated after microfiltration using vacuum evaporation. When the resulting highly concentrated micellar casein solution (>8% total solids) is heated to temperatures above 80°C, the viscosity continues to decrease as the temperature increases. Conversely, highly concentrated micellar casein will form a thermoreversible gel at low temperatures (<15°C). It can move back and forth from liquid to gel without changes in functionality as seen with spray drying.

FIGURE 2: FUNCTIONALITY OF MICELLAR CASEIN COMPARED WITH OTHER DAIRY PROTEIN POWDERS

	MCC	MPC	ACID CASEIN	CALCIUM CASEINATE	SODIUM CASEINATE
Wetting	■ ■ ■	■ ■ ■	■	■ ■ ■	■
Dispersibility	■ ■ ■	■ ■ ■	■	■ ■ ■	■ ■
Foaming	■ ■	■ ■	■	■ ■	■ ■ ■
Emulsion Capacity	■	■ ■	■	■	■ ■ ■ ■
Heat Stability at Neutral pH	■ ■ ■	■ ■	■	■ ■ ■	■ ■ ■
Viscosity	■ ■	■ ■	■	■ ■	■ ■ ■ ■
Solubility	■ ■ ■	■ ■ ■	■	■ ■	■ ■ ■

Very high = ■ ■ ■ ■ High = ■ ■ ■ Medium = ■ ■ Low = ■

The sensory profile of MCC also is similar to MPC as both are characterized by a mild flavor. Rennet and acid casein typically have a higher aroma intensity and dirty, brothy/animal off flavors that originate during their production.

FIGURE 3: SENSORY PROPERTIES OF MICELLAR CASEIN COMPARED WITH OTHER DAIRY PROTEIN POWDERS

	MICELLAR CASEIN	MPC80	MPC85	ACID CASEIN	RENNET CASEIN
Aroma Intensity	2.5^{c}	2.0^{c}	1.2^{d}	4.5^{a}	3.7^{b}
Sweet Aromatic	1.2^{a}	0.5^{b}	1.5^{a}	ND	ND
Sour Aromatic	ND	ND	ND	1.8^{a}	ND
Cardboard	1.0^{c}	1.5^{c}	2.0^{b}	ND	2.8^{a}
Dirty, Brothy/Animal	ND	ND	ND	3.3^{a}	2.0^{b}
Tortilla	1.2^{c}	2.2^{b}	1.0^{c}	4.5^{a}	2.5^{b}
Soapy	ND	1.0^{a}	1.3^{a}	ND	ND
Fatty	ND	1.0^{a}	ND	ND	ND
Sour Taste	ND	ND	ND	1.0^{a}	ND

Values represent pooled means from duplicated panel measurements. Intensities were scored on a 0–15 point universal Spectrum™ intensity scale where 0 = absence of the attribute and 15 = very high intensity of the attribute. Pooled means in a row followed by different letters are different ($p < 0.05$). ND = not detected.

What are the potential applications for MCC?

BEVERAGES

- Excellent fit in shelf-stable, protein-fortified beverages because of its heat stability
- Similar mouthfeel to 1.5% to 2% fat milk, making it suitable for low-fat versions of these beverages
- Low level of lactose, mild flavor and delivery of calcium and phosphorus

FOOD APPLICATIONS

- Provides heat stability, viscosity and water binding in retort processed foods, including protein-fortified soups, sauces and ready-to-eat meals
- Low lactose content
- Mild flavor

DRY DRINK MIXES

- Excellent wetting and dispersibility
- Slow-digesting protein keeps amino acid levels elevated for several hours
- Allows the body to repair and build muscle tissues for a prolonged period after exercise

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