TECHNICAL WHITE PAPER:

Creating delightful cocoa milk drinks

Creating dairy drinks joy for everyone

Flavored dairy milk drinks are a staple in many households' fridges. They offer a tasty treat that's typically consumed at breakfast time. Yet, the category has been commoditized, with cost being the top purchase driver.*

With consumer household budgets getting stretched further, dairy alternatives claiming shelf space and more attention being paid to how the products look both inside and out (packaging, ingredients list, and nutritional profile), perfecting your offering to help address the exact consumer needs has become more important than ever to ensure you're standing out from the crowd.

While flavored milk drinks recipes may seem "simple," there are endless possibilities to tailor end products by changing some of the parameters. To do so, you need a partner with the expertise to cater solutions to your processes and requirements, while at the same offering the critical ingredients to help you deliver the consumer-pleasing products that consumers have come to know and love.

In this white paper, our R&D experts, Benjamin, Dick, Ewa, Gueba and Marta, shed some light on the challenges faced when creating flavored drinks and the solutions that Cargill Food can provide to overcome them.

A "flavored milk drinks" definition

The flavored milk drinks category includes cocoa milks and flavored dairy milks:

- **Cocoa milks** are sweetened milks that contain various amounts of chocolate and/or cocoa powder. They are stabilized at different levels, depending on local/regional preferences.
- **Flavored dairy milks** are sweetened and flavored milks such as strawberry or banana flavor. A small portion of these are flavored through the inclusion of fruit juices.

Out of scope for the "flavored milk drinks" sector are recombined chocolate dairy drinks. *These are products that are sweetened with cocoa but made with milk ingredients instead of liquid milk.*

MEET OUR CARGILL EXPERTS

Benjamin Chanet
R&D Senior Application Specialist for dairy and dairy alternatives

Dick Brinkman
R&D Technical Account Manager Director

Ewa Kaliszan
R&D Senior Technical Account manager for dairy and dairy alternatives

Gueba Agoda-Tandjawa
R&D Rheology Senior Specialist

Marta Panasik
R&D Senior Technical Account manager for dairy and dairy alternatives

*Source: Innova Market Insights category survey 2025, European average.

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Critical elements for flavored milk drinks

For this white paper, we are deep-diving into cocoa milk drinks.

Cocoa milk drinks are characterized by a higher pH and low viscosity. There are multiple options to differentiate formulations according to milk base, flavoring, viscosity, shelf-life, and process conditions.

Key elements to understand:

Type of milk base
Whole, low fat, skimmed or powdered

Formulation parameters
Percentage of fat, proteins, sugars, stabilizers etc.

Flavoring
Plain, chocolate, fruit etc..

Texture
Thin, thick, creamy etc.

Shelf life
Short (1-3 weeks) to long (2-9 months)

Processing
Type of sterilization (UHT, retort, pasteurization)

There are 3 production processes which will require adaptations to the recipe.

Pasteurization *For short shelf-life products*	UHT *For long shelf-life products*	Retort *For long shelf-life products*
Milk standardization	Milk standardization	Milk standardization
Blending	Blending	Blending
Pre-Heating	Pasteurization	Pre-Heating
Homogenization (upstream)	**Homogenization (upstream)**	**Homogenization**
Pasteurization	UHT sterilization (direct/indirect)	Filling in cans or glass bottle
Pre-cooling	Pre-cooling	**Retort sterilization**
Cooling from 5° to 10°C	**Homogenization (downstream)**	**Cooling from 30° to 45°C**
Packaging (plastic or glass bottle)	**Cooling from 5° to 25°C**	
	Packaging (Tetra Brik or plastic bottle)	

KEY STEPS

Homogenization:

- Reduces the size of the fat particles
- Gives the drink physical stability (prevent phase separation
- Can be placed before or after heat treatment (in the case of UHT processing)

Cooling below 7°C:

- Prevent microbiological contamination
- In case of UHT treatment, product can be stored at ambient temperature, so no need to go below 7°C

Retort sterilization:

- Preserves the microbiological integrity
- Products can be stored at ambient temperature

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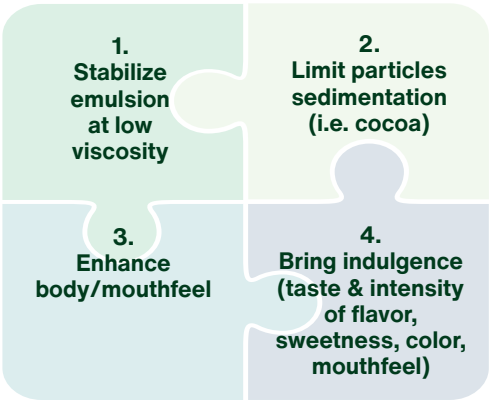
Stepping up to the challenge

The key challenges faced when creating delightful cocoa drinks are due to the low viscosity of these types of products. They can be summarized into four basic areas:



The good news is that Cargill is your one-stop-shop to address all of these challenges.

The choice of texturizer is key to ensuring stability at low viscosity and at very low dosage levels. Carrageenan is the go-to stabilizer as it's an attractive cost-in-use solution for neutral dairy products. This is primarily thanks to its strong synergy with proteins.

Essentially, challenges 1-3 can be addressed as follows:

- Select the appropriate stabilizer according to process, dosage and texture needs.
- Achieve the optimum protein synergy.

Challenge 4 can be met by selecting the right cocoa powder and sweetening solution that can bring the required taste, color, and mouthfeel. This can potentially be complemented by chocolate.[1]

Managing the stability of a neutral dairy drink at a low viscosity is a real challenge. Choosing the right carrageenan and finetuning the dosage to the production parameters is therefore critical to ensuring a well-rounded drink with no or limited sedimentation."*

Ewa Kaliszan, R&D Senior Technical Account Manager, Dairy and Dairy Alternatives

A snapshot of Cargill hero ingredients for cocoa flavored dairy drinks

Carrageenan

Has **thickening, texturizing & stabilizing properties**, as well as a strong synergy with proteins. This makes it an attractive cost-in-use stabilizer.

Cocoa powder

Brings **indulgence** through taste, color and mouthfeel, and the desired intensity of flavor.

Stevia sweetener

Helps to deliver a **sweet taste** with minimal off-notes; enabling deeper sugar reduction.

[1] Depending on the market and type of offering, there can be a greater dosage of chocolate next to cocoa powders. More premium products would, for example, use both chocolate and cocoa powders.

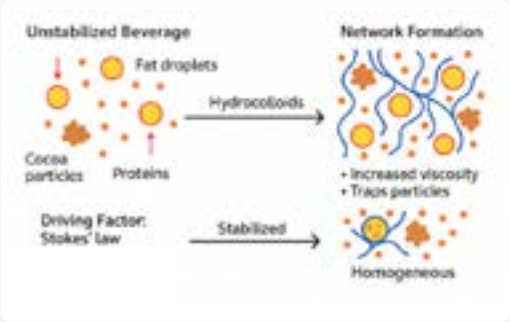
[2] In some markets, customers prefer light sedimentation as it signals the presence of chocolate, and consumers expect they have to shake the drink for the best experience.

Technical role of carrageenan in stabilizing cocoa-flavored beverages

Carrageenan is used in cocoa-flavored beverages for its thickening and stabilizing properties. Gueba explains that its effectiveness is largely due to its positive interaction with milk proteins at a neutral pH. This allows it to form a network that stabilizes the beverage matrix, and helps to create a creamy, viscous texture while preventing phase separation (such as sedimentation of the cocoa particles). This interaction is essential for both the mouthfeel and the shelf-life of the beverage.

Let's explore this network formation in more detail by assessing the impact of particle interactions on stability.

Network formation in beverages and the impact of particle interactions on stability



On the left-hand side of the diagram we see three components:

- **Cocoa particles (brown clusters):** Higher density than water, so they tend to settle downward.
- **Fat droplets (yellow spheres):** Lower density than water, so they tend to float upward.
- **Proteins (small red dots):** Dispersed in the liquid.

So without carrageenan, the particles move freely under gravity. As a result the cocoa particles will sediment at the bottom and fat droplets will rise to the top i.e., **"phase separation"** *(see sidebar)*.

On the right-hand side of the diagram above we see a homogenous and stable beverage thanks to the addition of carrageenan — shown as blue network-like structures.

Key mechanism of network formation:

- Carrageenan forms a **three-dimensional network** that traps cocoa particles, fat droplets, and proteins.
- Increased viscosity (η in Stokes' law), and network entanglement reduce particle mobility, preventing sedimentation and creaming.
- **The result is a homogeneous and stable beverage** with an improved texture.

Driving force:

Stokes' law governs sedimentation:
$T=d2(\rho1-\rho2)g18\eta T = \frac{d^2 (\rho_1 - \rho_2) g}{18 \eta}$
$T=18\eta d2(\rho1-\rho2)g$

- **d** = particle diameter.
- $\rho_1 - \rho_2$ = density difference between particle and medium.
- **g** = gravity.
- η = viscosity of the medium.
- Larger particles and greater density differences accelerate separation.

SUMMARY

1

Non-stabilized beverage:
Cocoa settles, and fat rises (Stokes' law)

2

Addition of hydrocolloids:
Network formation

3

Stabilized beverage:
Increased viscosity, trapped particles, and homogeneous system

Factors impacting carrageenan-milk interaction

The gelling carrageenan/casein interaction is due to the formation of an electrostatic complex which leads to the adsorption of kappa or iota carrageenan onto the casein micelle surface.

Two factors influence this carrageenan/ protein interaction, e.g. temperature and pH.

- **Temperature:** Carrageenan helix formation increases charge density, which boosts the probability of electrostatic interactions with proteins, and resultantly leads to a more stable beverage structure.
- **pH:** pH changes can significantly affect stabilization. Maintaining pH between 6.6 and 7.0 ensures proper stabilization in carrageenan-protein systems.

Also the alkalinity of the cocoa powder can further influence these interactions and needs to be carefully monitored.

The power of cocoa powder

Non-alkalized powders should be avoided as they may present a sour taste which can make dairy products seem spoiled. Additionally, strongly alkalized powders may be too dark and grayish, which can result in a muddy color in dairy drinks."

Dick Brinkman, R&D Technical Account Manager Director

In cocoa flavored milk drinks, cocoa powders bring indulgence through taste, color, and mouthfeel. However, there are some considerations that can lead to changes in the structure of the final product e.g., switching the cocoa powder and resultantly the alkalinity content (pH).

Cargill's cocoa powder experts will work with you to understand and control the most important quality parameters.

Key quality parameters for cocoa powders in cocoa flavored milk drinks:

- **Color:** Intense and bright colors are typically desired.
- **Flavor:** High quality flavors with no off-flavors are desired.
- **Fineness:** Finer products are desired.
- **Moisture:** A minimal moisture level is desired, as a high moisture content might lead to the growth of microorganisms.
- **Microorganisms:** A minimal microorganism level is desired, especially heat-resistant spores forming bacteria in dairy drinks.

The Cocoa Collection by Gerkens®

gerkens
a Cargill brand

Cargill combines sensory expertise with deep application knowledge to achieve tailored cocoa powder solutions that exceed customer expectations. Our extensive range of Gerkens® cocoa powders is specially blended to deliver consistent and reliable cocoa powders for everyday use. The Cocoa Collection by Gerkens® offers endless possibilities. Adding color and intensity to distinctive signature tastes makes them the ideal ingredient to transform your creation into a sensorial masterpiece.

In short, they offer: "Consistency you can taste, quality you can trust."

A rich cocoa flavored milk drink that balances lower sugars with indulgence

At Cargill, we truly understand dairy formulations, ingredient interactions, and manufacturing processes. That's why our dairy & dairy alternatives application team can produce finished product prototypes. We also have the know-how to control and characterize (rheology & panel tasting) different properties and design specific ranges of solutions per sub-application.

It is this combination of expertise and unparalleled solutions portfolio that offers you the tools to help meet the distinct needs of your consumers.

To demonstrate the possibilities, our application experts have created a Nutri-Score B cocoa flavored milk drink that perfectly balances a lower sugar formulation with creamy indulgence.

The result is a balanced, yet indulgent, creamy drink, that fits perfectly with changing attitudes towards what is permissible and nutritious.

The prototype uses these three critical ingredients:

Carrageenan

Satiagel® ABN522 SB helps to optimize the stabilizing network at a very low dosage to limit viscosity during heat treatment, prevent insoluble particles from sedimentation, improve mouthfeel, and bring a smooth texture.

Low fat cocoa powder

Gerkens® Sweety SRB 200 helps to reduce sugar by up to 30% thanks to its mild flavor profile and strong creaminess. This solution won the FiE Sensory Innovation Award 2022.

Sweetener

EverSweet®*, a next-generation stevia sweetener produced by fermentation, helps to deliver a sweet taste with minimal off-notes.

*EverSweet® is a product of Avansya, a joint venture between Cargill and dsm-firmenich.

Indulgent yet balanced cocoa milk drink

The broadness of Cargill's portfolio enables you to leverage the best solutions to get to the desired end result. Complete sugar reduction of a cocoa-flavored milk drink (typically Sucrose Equivalent Value (SEV) 7) proves challenging when solely using label-friendly ingredients. With leaf-based stevia sweeteners you can typically "only" reach a 5% SEV reduction with a good taste profile. By leveraging EverSweet® next-generation stevia sweetener and Gerkens® Sweety cocoa powder our application experts are now able to reach the full sugar reduction without impacting the chocolate flavor we all know and love.

Ingredients	%
Skimmed milk	Up to 100
Cream 35% fat	3.80
Cocoa powder (Gerkens® SRB 200)	**1.30**
Vanilla flavor	0.12
Steviol glycosides from fermentation (EverSweet®)	**0.018**
Carrageenan: (Satiagel® ABN 522 SB)	**0.012**

Nutrition facts	
Amount per serving (100ml)	
Energy kJ	202
Energy kcal	48.3
Fats	1.5
of which saturated	1.0
Carbohydrates	4.9
of which sugars	4.8
Proteins	3.6
Fibers	0.0
Salt	0.1

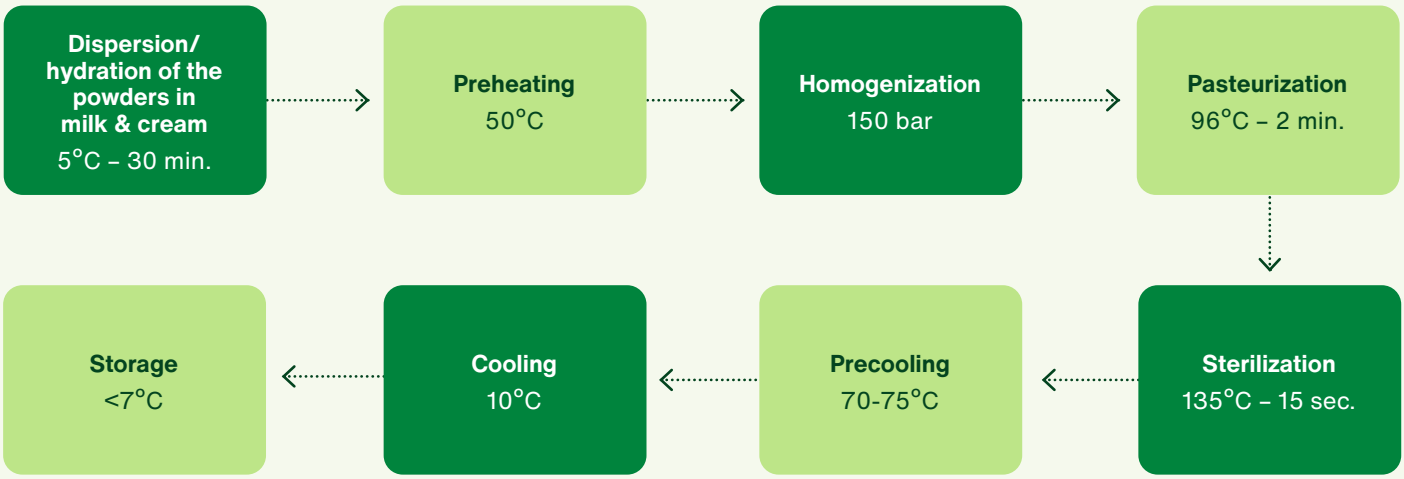
Nutri-Score based on 2024 updated algorithm.

NUTRI-SCORE A B C D E

To ensure a rich yet balanced taste, we optimized Gerkens® Sweety cocoa powder and EverSweet® next-generation stevia sweetener. In this way we are delivering indulgence without compromising on the classic chocolate flavor that consumers expect."

Benjamin Chanet, R&D Senior Application Specialist, Dairy & Dairy Alternatives

PREPARATION



Dial it up

Indulgence

The Cocoa Collection by Gerkens® covers both essential and specialty cocoa powders that can help address specific needs such as differentiated sensorial experience.

It features the **Indulgence Booster** range, which is a curated collection of premium cocoa powders, that's been crafted to create a powerful connection between flavor and childhood memories. This line delivers a sophisticated, grown-up take on classic chocolate indulgence by combining deep, rich colors with signature flavors that evoke a sense of comforting nostalgia.

SRB 300 cocoa powder, for example, is particularly well suited for dairy drinks. In sensory research, this powder performed on par with the segment leader and outperformed other standard cocoa powders found in retail.[1]

It is a low fat powder that's characterized by a dark red brown color, and brings an indulgent profile in full sugar, reduced sugar and no added sugar (NAS) chocolate dairy drink recipes. In NAS applications, it masks the bitterness and lingering of sweetness aftertaste.

SRB300 cocoa powder: Flavor & Color profile

pH 7.1

L-value 13.8

a-value 7.6

b-value 6.2

a/b value 1.24

Label-friendliness

Ewa explains how customer interest in trying WavePure® seaweed powder in dairy and non-dairy drinks is on the rise. This label-friendly, unique ingredient is based on seaweed that can be labeled[2] as "(Red) Gracilaria Seaweed Powder" or "(Whole) Gracilaria Seaweed."

WavePure® can contribute to mouthfeel without impacting indulgence. And at low dosage levels it offers suspension and stabilization properties that can help to prevent phase separation over shelf-life. **Cargill currently offers a tailored product for use in protein drinks based on dairy or plant-based ingredients (ABN 8140).**

WavePure®
Seaweed powder

WavePure® whole, not-transformed seaweed, reproducible thanks to Cargill's expertise is your solution for label-friendly, high-quality formulations!

[1] Cargill proprietary sensory research – central location test, N=600+ consumers in France, Poland and US, June 2024.

[2] The labeling, substantiation and decision making of all claims is the customers' responsibility. We recommend you consult regulatory and legal advisors familiar with applicable laws, rules and regulations prior to making labeling claims decisions for your products.

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Plant-based drinks to the fore

Chocolate flavored oat milk alternative

Cargill's dairy R&D team is not just working on dairy applications. They also have broad expertise in knowledge building and supporting customers on plant-based and hybrid dairy projects.

Marta is keen to point out how – through close collaboration with our Sensory Science team – we are able to inspire customers through mouthwatering prototypes.

Ingredients	%
Water	Up to 100
Oat syrup	10.0
Sugar	4.3
Fat-reduced cocoa powder (Gerkens® 10-12 DP70)	**1.2**
High oleic sunflower oil/ Rapeseed oil	**1.0**
Calcium phosphate	0.31
Salt	0.1
Stabilizers: Guar gum, gellan gum (Lygomme® QBN 330)	**0.06**
Flavor	QS

Nutrition facts	
Amount per serving (100ml)	
Energy	62 kcal
Fats	1.6
of which saturated	0.2
Carbohydrates	11
of which sugars	7.5
Proteins	0.5
Fibers	0.3
Salt %	0.1

Gerkens® DP70 Cocoa powder: Color profile

This low in saturated fats drink leverages the power of Gerkens® DP70 cocoa powder. Gerkens® DP70 cocoa powder has a flavor profile with strong cocoa and bitter notes that provides an excellent match for oat-based drinks.

How did we get to this match between Gerkens DP70 cocoa powder and the oat base??

First our experts mapped the plant-based drinks, concluding that oat milk is usually more watery, bitter and has cereal notes.

Based on further sensory profiling through professionally trained panels and consumer tests,* they were able to identify the best cocoa powder to pair with oat plant-based alternatives for a delicious chocolate, plant-based experience.

This powder scored the highest in overall liking for 7 in 10 consumers and also achieved the highest purchase intent (55% stating they would "definitely" or "probably" buy this cocoa flavored oat drink).

Through sensory science we can find the best matching cocoa powders for the plant base. Gerkens® DP70 cocoa powder has a similar profile to oat milk, which helps to smooth out the flavor. The result is a well-balanced chocolate oat drink with a pleasant cocoa flavor."

Marta Panasik, R&D Senior Technical Account Manager, Dairy & Dairy Alternatives

*Cargill Consumer Community test in 3 countries with 93 consumers in the UK, France and Germany.

How Cargill can help

In Europe, Cargill has a long-standing expertise in everything dairy.

Cargill's R&D teams support our customers from two locations (Baupte (France) and Vilvoorde (Belgium)) which have fully equipped pilot plant facilities (incl. UHT, freezer, and fermentation tanks).

Moreover, our facilities feature a whipping machine to create mousses (Mondomix) and benchtop capabilities (<5kg). Furthermore, they house a wide range of analytical tools to measure anything from pH, viscosity, gel strength, firmness and whippability, to moisture and accelerated aging analysis.

Combined with our broad portfolio of high-quality ingredients for dairy, plant-based & hybrid alternatives, and our sensory expertise, these capabilities enable us to offer technical assistance as well as co-create new concepts and/or reformulate existing recipes. Whether you're innovating or reformulating for cost, health, label-friendliness or indulgence, we are your partner across dairy applications.

Cargill can support you across all dairy applications:

- Fermented products
- Dairy desserts
- Dairy beverages
- Creams
- Processed & spreadable cheese
- Dairy powders & creamers
- Dairy dry mixes

Our application teams can also support hybrid or plant-based alternatives to dairy.

With high-quality ingredients:

- Texturizers
- Functional systems
- Fibers
- Sweeteners
- Cocoa & chocolate
- Decorations & inclusions
- Edible oils & fats
- Plant proteins

What's next?

While the flavored dairy drinks market is seeing renewed interest, brands must navigate changing consumer needs, reduced spending power, regulatory pressures around sugar reduction & sustainability, and increased consumer expectations around transparency.

With an expert partner by your side, finding innovation opportunities and executing them becomes much easier. Thanks to Cargill's dairy and ingredient formulation expertise and broad portfolio of critical ingredients (e.g., texturizers and cocoa & chocolate), we can help you find the right balance between taste, cost and indulgence.

The future of dairy drinks looks bright.
Let's co-create it together!

MORE INFORMATION >

OUR CARGILL EXPERTS

Benjamin Chanet
R&D Senior Application Specialist for dairy and dairy alternatives

Benjamin joined Cargill a year ago as Senior Dairy and Dairy Alternatives Application Specialist and works in the Dairy Application Centre in Baupte, France. During his 27 years in the dairy Industry across various international markets (from Continental Europe, UK to Brazil), he has developed a deep knowledge in dairy products & processes and knows how to merge the voice of the customer with dairy science. He supports Cargill's customer facing teams to meet customer needs and exceed their expectations.

Dick Brinkman
R&D Technical Account Manager Director

Dick joined Cargill 22 years ago as manager of the cocoa technical service team. In this role, he contributed significantly to the impressive growth of Cargill's cocoa business. Before joining Cargill, he worked with two other cocoa manufacturers in various roles in both PPD and Cocoa Applications. Three years ago, Dick moved into an R&D category role where he is currently leading the Bakery Technical Account Managers team.

Ewa Kaliszan
R&D Senior Technical Account manager for dairy and dairy alternatives

Ewa is with Cargill for 18 years, currently working as Senior Dairy and Dairy Alternatives Technical Account Manager after also holding commercial roles. Based in Poland, she looks after customers in Central Eastern Europe and the Nordics. Graduated from the University of Rostock in Germany, she holds over 35 years' experience in the food ingredients industry. Ewa brings her passion to everyday customer interactions as she's solving technical challenges, but she thrives the most working on new product innovation.

Gueba Agoda-Tandjawa
R&D Rheology Senior Specialist

With over 19 years of experience, of which more than 12 years at Cargill, Guéba has built a strong track record in the food production industry. His expertise spans R&D, innovative product & process design, and the science of food ingredients such as texturizers, hydrocolloids, and related (bio)macromolecules. He is skilled in Food Physics & Structure, Physical Chemistry, Food Processing, and Chemical Engineering, driving solutions that combine scientific rigor with practical applications to create value-added products.

Marta Panasik
R&D Senior Technical Account manager for dairy and dairy alternatives

Marta is a Dipl. Ing. with over 20 years of experience in the food industry across different R&D functions both in B2B and B2C businesses. Marta joined Cargill 3 years ago where she led the application program for capability building in dairy alternatives for Europe. Marta has built up extensive knowledge of various ingredients such as fats and oils, proteins, starches, sweeteners and hydrocolloids, which she leverages every day in her current role as Senior Technical Account Manager. Passionate about dairy in the broadest sense, she thrives when co-creating projects with customers, be it dairy, alternatives or hybrids.

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