



european whey processors association



Semicarbazide (SEM) in Dairy Ingredients

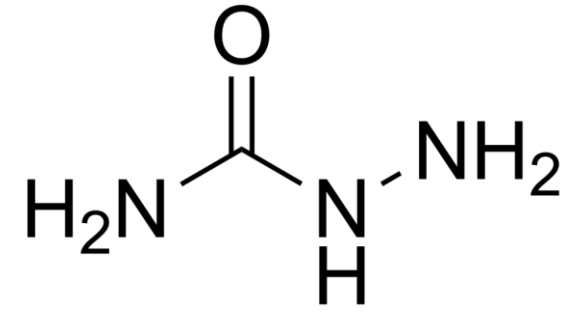
EWPA/EDA work towards a better regulatory solution and achieving best practices in the dairy industry

Stakeholder Discussion Group on Emerging Risk (StaDG-ER) –
Meeting 13-14 June

Semicarbazide in milk protein ingredients: the context and key questions

- What is semicarbazide?
- Why is semicarbazide a concern?
- Why is semicarbazide found in some milk protein ingredients?
- What are the main factors affecting semicarbazide in milk protein ingredients?
- How can semicarbazide formation in milk protein ingredients be mitigated?

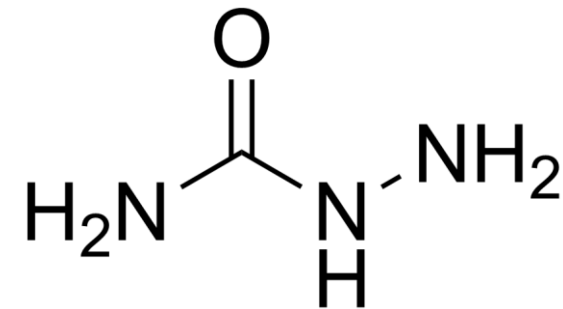
What is semicarbazide?



Semicarbazide [H₂NC(=O)NH-NH₂]

- Semicarbazide is a hydrazine derivative of urea where one of the amino groups has been replaced with hydrazine
- Semicarbazide can be formed via various other routes
- Semicarbazide is also a metabolite of the nitrofurans compound nitrofurazone
- Semicarbazide has been detected in food products that have never been exposed to nitrofurazone which include meat, fruit and vegetables packed in glass jars, bread, bakery products, noodles, seafood, powdered egg, honey, and powdered dairy products.
- Understanding the origin of semicarbazide in food products is critical

Why is semicarbazide a concern?



Semicarbazide [H₂NC(=O)NH-NH₂]

- Semicarbazide is a hydrazine derivative of urea where one of the amino groups has been replaced with hydrazine
- Semicarbazide can be formed via various other routes
- Semicarbazide is also a metabolite of the nitrofurantoin compound nitrofurazone
- Semicarbazide has been detected in food products that have never been exposed to nitrofurazone which include meat, fruit and vegetables packed in glass jars, bread, bakery products, noodles, seafood, powdered egg, honey, and powdered dairy products.
- Understanding the origin of semicarbazide in food products is critical

Why does semicarbazide occur in dairy ingredients?

- Two potential causes of semicarbazide in dairy ingredients:
 1. *Semicarbazide occurs as nitrofurazone metabolite arising from the illegal use of nitrofurans*
 2. *Semicarbazide is formed from indigenous compounds of milk and dairy products in the absence of nitrofurazone*
- These two causes for semicarbazide need to be separated to avoid erroneously attributing the presence of semicarbazide in dairy ingredients to nitrofuran use
- This is also recognized in EU COM Reg. (EU) 2023/411 amending Regulation (EU) 2019/1871 as regards the application of reference points for action for nitrofurans and their metabolites (published on 24 February 2023)

Semicarbazide as a marker for nitrofurazone

- Testing of SEM as a marker for nitrofurazone derived from meat products, where nitrofurazone is highly unstable and as a result SEM needs to be detected
- Nitrofurazone very stable in milk and dairy products
- International standard available for determining nitrofurazone in milk and milk products



Reference numbers
ISO 22186:2020(E)
IDF 245:2020(E)

© ISO and IDF 2020

INTERNATIONAL
STANDARD

**ISO
22186**

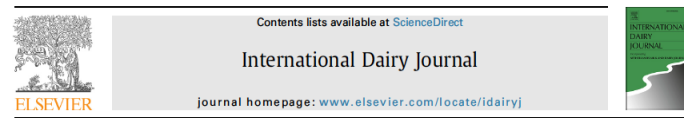
IDF 245

First edition
2020-09

**Milk and milk products —
Determination of nitrofurazone**

Lait et produits laitiers — Détermination de la nitrofurazone

International Dairy Journal 91 (2019) 185–192



Contents lists available at ScienceDirect

International Dairy Journal

journal homepage: www.elsevier.com/locate/idaairyj

Determination of nitrofurazone in fluid milk and dairy powders. Part 1: An international pilot study

Justin G. Bendall ^{a,*}, Robert A. Crawford ^b, Jaap M. Evers ^a, Betty W. Smythe ^a, Thomas Bessaire ^c, Pascal Mottier ^c, Claudia Mujahid ^c, Gordana Aleksic ^d, Robert Hutchinson ^d

^a Fonterra Research and Development Centre, Dairy Farm Road, Private Bag 11029, Palmerston North 4442, New Zealand

^b Fonterra Co-operative Group Ltd, 80 London Street, PO Box 459, Hamilton, New Zealand

^c Nestlé Research Center, Vers-chez-les-Blanc, PO Box 44, CH-1000 Lausanne 26, Switzerland

^d Global Proficiency Ltd, Ruakura Research Centre, 10 Bilsley Road, PO Box 20 474, Hamilton, New Zealand



International Dairy Journal 91 (2019) 193–199



Contents lists available at ScienceDirect

International Dairy Journal

journal homepage: www.elsevier.com/locate/idaairyj

Determination of nitrofurazone in fluid milk and dairy powders. Part 2: A full international collaborative study

Justin G. Bendall ^{a,*}, Robert A. Crawford ^b, Jaap M. Evers ^a, Gordana Aleksic ^c, Robert Hutchinson ^c

^a Fonterra Research and Development Centre, Dairy Farm Road, Private Bag 11029, Palmerston North 4442, New Zealand

^b Fonterra Co-operative Group Ltd, 80 London Street, PO Box 459, Hamilton, New Zealand

^c Global Proficiency Ltd, 10 Bilsley Road, Ruakura Research Centre, PO Box 20 474, Hamilton, New Zealand



EU COM Reg. (EU) 2023/411 amending Regulation (EU) 2019/1871 as regards the application of reference points for action for nitrofurans and their metabolites (published on 24 February 2023)

ANNEX

The Annex to Regulation (EU) 2019/1871 is replaced by the following:

ANNEX

Reference points for action (RPA)

Substance	RPA (µg/kg)	Other provisions
Chloramphenicol	0,15	
Malachite green	0,5	0,5 µg/kg for the sum of malachite green and leucomalachite green
Nitrofurans and their metabolites	0,5 ⁽¹⁾ ⁽²⁾	0,5 µg/kg for each of the metabolites of furazolidone (AOZ or 3-amino-2-oxazolidinone), furaltadone (AMAZ or 3-amino-5-methylmorpholino-2-oxazolidinone), nitrofurantoin (AHD or 1-aminohydantoin), nitrofurazone (SEM or semicarbazide) and nifursol (DNSH or 3,5-dinitrosalicylic acid hydrazide)

⁽¹⁾ Due to the natural occurrence of SEM in crayfish at levels above the RPA, only levels of AOZ, AMAZ, AHD and DNSH above the RPA are a clear indication of the illegal use of nitrofurans and their metabolites. The RPA of 0,5 µg/kg for SEM in crayfish shall only be applied when the illegal use of nitrofurazone or SEM on crayfish has been established, i.e. at least one of the other nitrofuran metabolites has been detected.

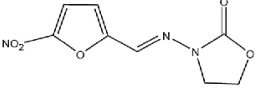
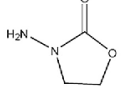
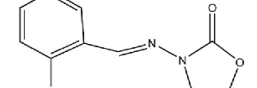
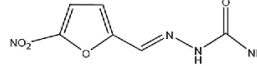
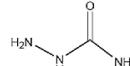
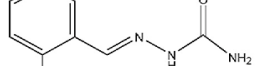
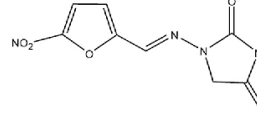
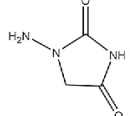
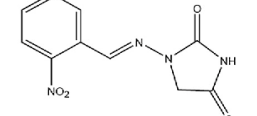
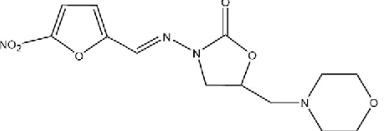
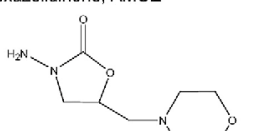
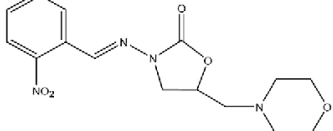
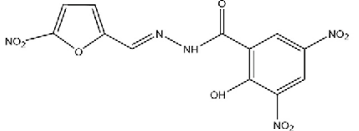
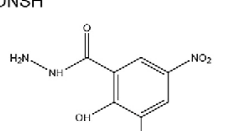
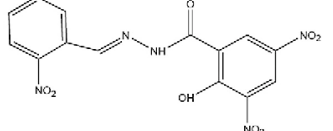
⁽²⁾ Due to the occurrence of SEM at levels above the RPA as the consequence of processing in gelatine, collagen hydrolysate, hydrolysed cartilage products, spray dried blood products, whew and milk protein concentrates, caseinates and milk powder (excluding infant formulae and follow-on formulae) only levels of AOZ, AMAZ, AHD and DNSH above the RPA are a clear indication of the illegal use of nitrofurans and their metabolites. The RPA of 0,5 µg/kg for SEM in gelatine, collagen hydrolysate, hydrolysed cartilage products, spray dried blood products, whew and milk protein concentrates, caseinates and milk powder (excluding infant formulae and follow-on formulae) shall only be applied, when the illegal use of nitrofurazone or SEM has been established, i.e. at least one of the other nitrofuran metabolites has been detected.

Food business operators and other interested parties shall communicate by 1 March 2024 to the Commission the results of investigations on the parameters and factors in the processing steps resulting in the formation of SEM in gelatine, collagen hydrolysate, hydrolysed cartilage products, spray dried blood products, whew and milk protein concentrates, caseinates and milk powder (excluding infant formulae and follow-on formulae) during processing. They shall also communicate the measures taken to ensure that the levels of SEM in these products are kept as low as reasonably achievable. In the absence of satisfactory data and information, measures shall be taken to end this exemption.'

Milk protein ingredients categories

- Whey protein concentrates
- Milk protein concentrates
- Milk powders (excluding infant formula and follow-on formula)
- Caseinates

Nitrofuran metabolites considered in EU COM Reg. (EU) 2023/411

Nitrofuran	Hydrolysed marker residue	Derivative for LC-MS/MS measurement
Furazolidone 	3-amino-oxazolidinone, AOZ 	NPAOZ 
Nitrofurazone 	Semicarbazide, SEM 	NPSEM 
Nitrofurantoin 	1-aminohydantoin, AHD 	NPAHD 
Furalladone 	3-amino-5-morpholinomethyl-1,3-oxazolidinone, AMOZ 	NPAMOZ 
Nifursol 	3,5-dinitrosalicylic acid hydrazide, DNSH 	NPDNSH 

DOI:10.1016/J.FOODCONT.2014.08.037

EU COM Reg. (EU) 2023/411 amending Regulation (EU) 2019/1871 as regards the application of reference points for action for nitrofurans and their metabolites (published on 24 February 2023)

ANNEX

The Annex to Regulation (EU) 2019/1871 is replaced by the following:

‘ANNEX

Reference points for action (RPA)

Substance	RPA (µg/kg)	Other provisions
Chloramphenicol	0,15	
Malachite green	0,5	0,5 µg/kg for the sum of malachite green and leucomalachite green
Nitrofurans and their metabolites	0,5 ⁽¹⁾ ⁽²⁾	0,5 µg/kg for each of the metabolites of furazolidone (AOZ or 3-amino-2-oxazolidinone), furaltadone (AMAZ or 3-amino-5-methylmorpholino-2-oxazolidinone), nitrofurantoin (AHD or 1-aminohydantoin), nitrofurazone (SEM or semicarbazide) and nifursol (DNSH or 3,5-dinitrosalicylic acid hydrazide)

⁽¹⁾ Due to the natural occurrence of SEM in crayfish at levels above the RPA, only levels of AOZ, AMAZ, AHD and DNSH above the RPA are a clear indication of the illegal use of nitrofurans and their metabolites. The RPA of 0,5 µg/kg for SEM in crayfish shall only be applied when the illegal use of nitrofurazone or SEM on crayfish has been established, i.e. at least one of the other nitrofurans metabolites has been detected.

⁽²⁾ Due to the occurrence of SEM at levels above the RPA as the consequence of processing in gelatine, collagen hydrolysate, hydrolysed cartilage products, spray dried blood products, whew and milk protein concentrates, caseinates and milk powder (excluding infant formulae and follow-on formulae) only levels of AOZ, AMAZ, AHD and DNSH above the RPA are a clear indication of the illegal use of nitrofurans and their metabolites. The RPA of 0,5 µg/kg for SEM in gelatine, collagen hydrolysate, hydrolysed cartilage products, spray dried blood products, whew and milk protein concentrates, caseinates and milk powder (excluding infant formulae and follow-on formulae) shall only be applied, when the illegal use of nitrofurazone or SEM has been established, i.e. at least one of the other nitrofurans metabolites has been detected.

Food business operators and other interested parties shall communicate by 1 March 2024 to the Commission the results of investigations on the parameters and factors in the processing steps resulting in the formation of SEM in gelatine, collagen hydrolysate, hydrolysed cartilage products, spray dried blood products, whew and milk protein concentrates, caseinates and milk powder (excluding infant formulae and follow-on formulae) during processing. They shall also communicate the measures taken to ensure that the levels of SEM in these products are kept as low as reasonably achievable. In the absence of satisfactory data and information, measures shall be taken to end this exemption.’

Milk protein ingredients categories

- Whey protein concentrates
- Milk protein concentrates
- Milk powders (excluding infant formula and follow-on formula)
- Caseinates

02 February, 2024

Semicarbazide and other nitrofuran metabolites in milk protein ingredients

A report prepared by the EDA/EWPA Task Force on Semicarbazide in Dairy
Products and Ingredients

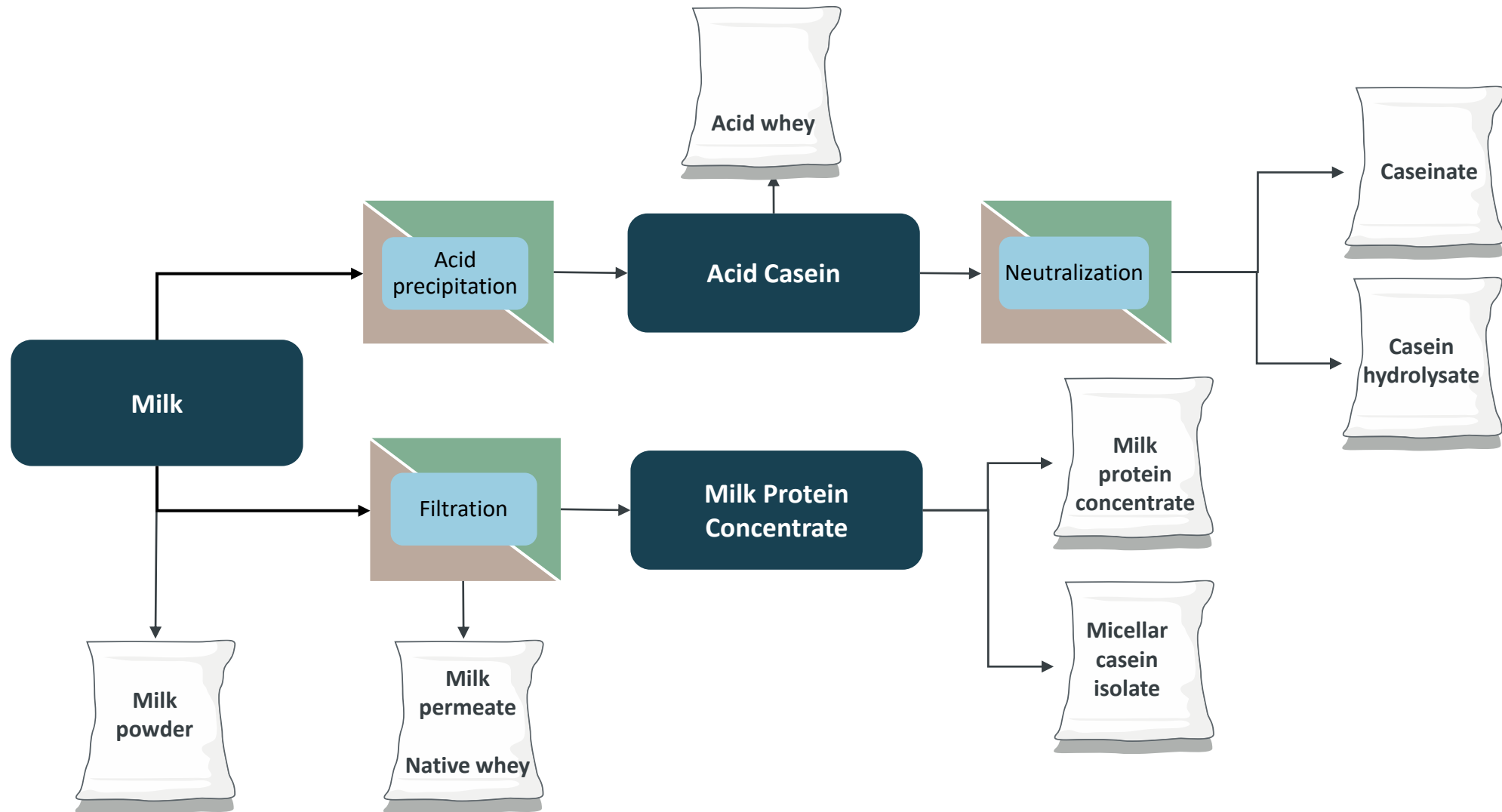


EDA/EWPA Task Force on Semicarbazide in Dairy Products and Ingredients

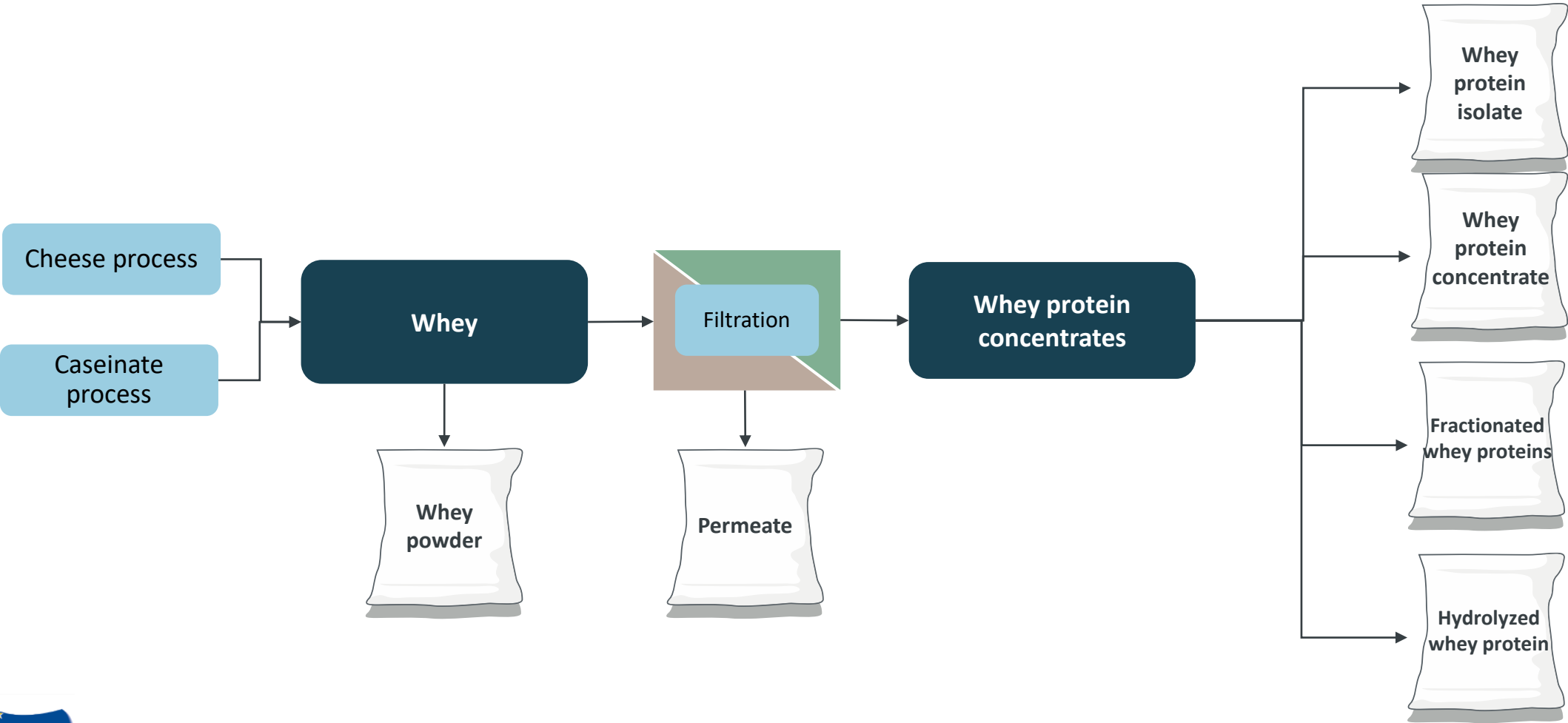
Task force members:

- Kinga Adamaszwili (EDA/EWPA, Belgium)
- Justin Bendall (Fonterra, New Zealand)
- Diane Durand-Reville (Savencia, France)
- Thom Huppertz (FrieslandCampina, The Netherlands)
- Ove Jensen (Arla Foods Ingredients, Denmark)
- Christian Kastrup (Danish Agriculture and Food Council, Denmark)
- Nicolas Marechal (Savencia, France)
- Mirka Marescot (Euroserum, France)
- Anna Kousholt (Fonterra, The Netherlands)
- Colin Ray (Arla Foods Ingredients, Denmark)
- Geertje van der Rijdt (FrieslandCampina, The Netherlands)
- Peter Skou (Arla Foods Ingredients, Denmark)

Preparation of milk protein ingredients



Preparation of whey protein ingredients



Key questions to be answered by the investigations

1. Does semicarbazide occur in dairy ingredients?
2. Is the occurrence of semicarbazide in dairy ingredients due to the use of nitrofurazone?
3. What are the main factors contributing to process-induced semicarbazide formation in dairy products and ingredients?
4. What are mitigation actions to minimize process-induced semicarbazide formation in dairy products and ingredients?



Investigating semicarbazide in dairy ingredients

Approaches taken

- Literature research
- Commercial product monitoring
- Experimental samples to underpin mechanisms





Semicarbazide in dairy ingredients

Learnings from Scientific Literature



Learnings from scientific literature

Presence of SEM in dairy products and ingredients

Table 1. Occurrence of SEM in milk and dairy ingredients (global pool).

Milk and dairy products	Number of samples	% Positive*	Range (µg/kg)	Average (µg/kg) ***
Whey and milk protein concentrates	118	35	< 0.5–13	2.2
Sweet buttermilk powder	75	27	< 0.5–1.7	0.8
Caseinate	204	9.3	< 0.5–1.1	0.75
Milk powder (skim, whole milk)	924	0.5	< 0.5–6.2	4.3
Lactose	109	0	–	–
Cheese**	35	0	–	–
Yoghurt (including powder)	29	0	–	–
Butter	4	0	–	–
Fresh milk	153	0	–	–

*Above 0.5 µg/kg.

**Soft and hard cheeses; Sbrinz, Gruyere, Emmental, Cheddar.

***Of positive samples only.

- SEM detected in dried protein-containing dairy products
- SEM detected in:
 - Whey and milk protein concentrates
 - Sweet buttermilk powder
 - Caseinate
 - Milk powder
- SEM not detected in:
 - Lactose
 - Cheese
 - Yoghurt and yoghurt powder
 - Butter
 - Fresh milk

Learnings from scientific literature

Impact of storage on SEM formation in milk protein concentrate

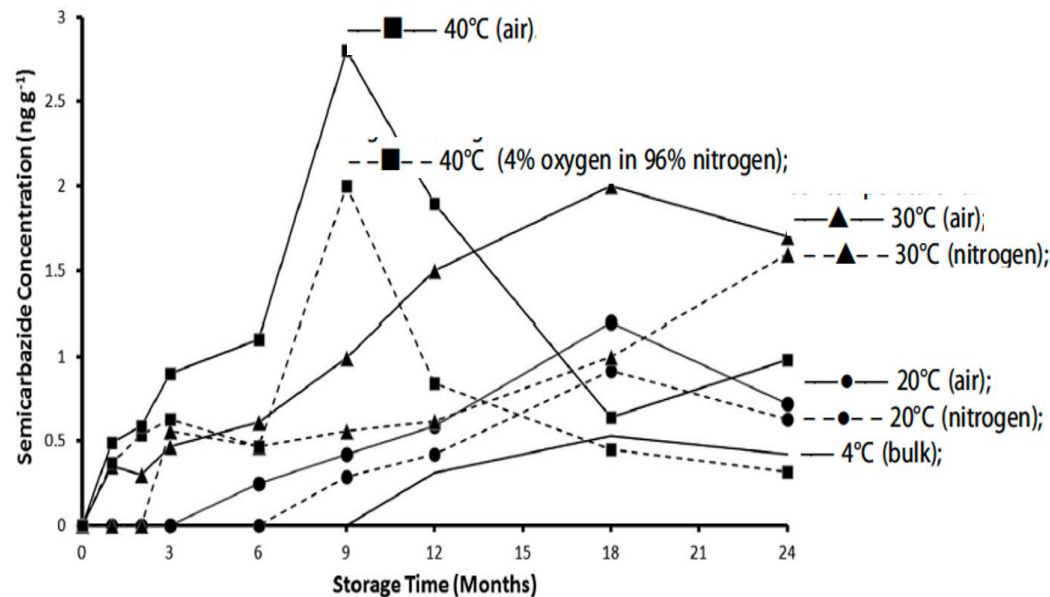
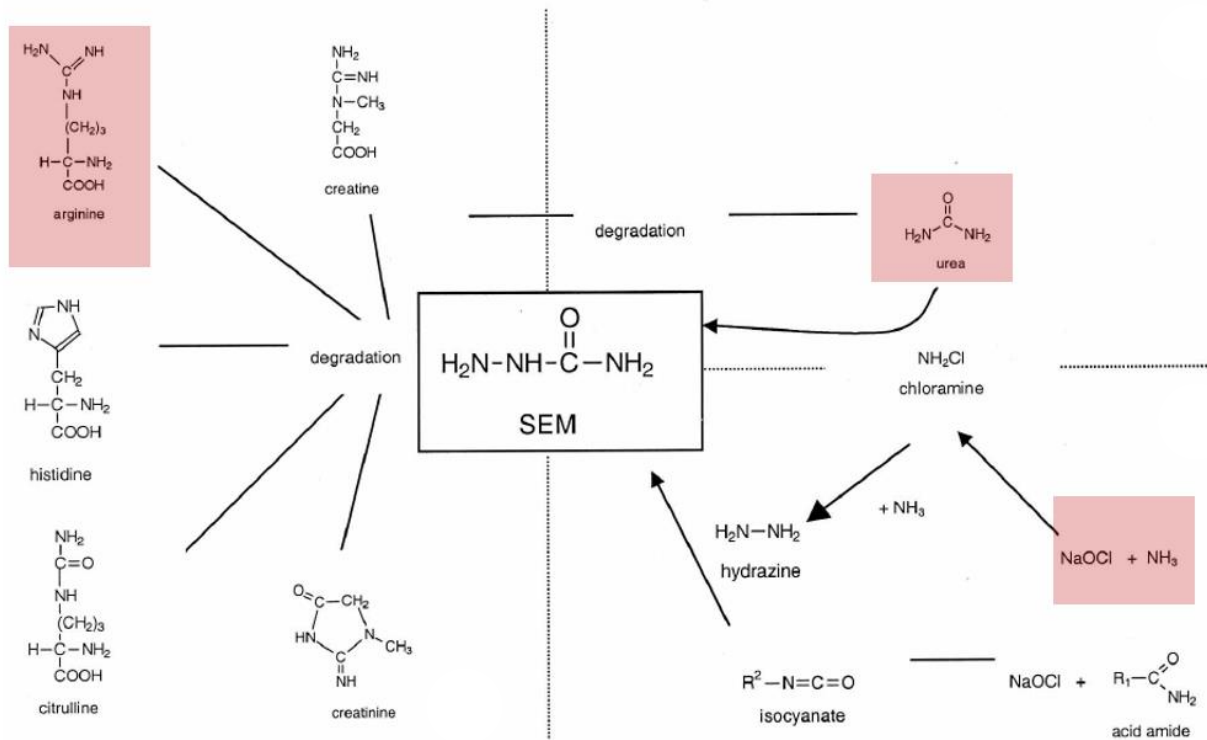


Figure 2. Semicarbazide development in MPC85 during storage. Line styles indicate various temperature and gas-flushing conditions: — 4°C (bulk); - - ● - - 20°C (nitrogen); —●— 20°C (air); - - ▲ - - 30°C (nitrogen); —▲— 30°C (air); - - ■ - - 40°C (4% oxygen in 96% nitrogen); and —■— 40°C (air).

- Milk protein concentrate (MPC85) stored at various conditions
- No SEM detected in MPC after production
- Development of SEM during storage
- Quicker and more extensive SEM development at higher storage temperature
- Quicker and more extensive SEM development with air in headspace

Learnings from scientific literature

Possible routes for SEM formation



Important expected contributors to process-induced SEM formation in dairy ingredients:

- Arginine (present in all proteins)
- Urea (naturally present in milk)
- Hypochlorite (may be used in decontamination)

Figure 4. Possible reaction pathways for the formation of semicarbazide (SEM) from different precursors.

Learnings from scientific literature:

Main conclusions from scientific literature:

- Mentioned contributors are urea, hypochlorite and elevated pH
- SEM not detected in liquid samples but detected in (spray-dried) powders
- Urea addition enhanced SEM formation
- Key suspected role of the amino acid arginine
- SEM formation continues (or sometimes even starts) during storage of powders
- SEM is not a stable end-product



SEM in milk protein ingredients

Learnings from Monitoring and Experimental Investigations



Monitoring of SEM in dairy ingredients

Nitrofuran metabolite	Samples analyzed	Samples negative	Samples positive	Detection frequency
SEM	486	377	109	22.4%
AOZ	486	486	0	0%
AMOZ	486	486	0	0%
AHD	486	486	0	0%
DNSH	89	89	0	0%

- SEM detected in 109 out of 486 dairy ingredients analyzed in monitoring
- AOZ, AMOZ, AHD and DNSH not detected in any dairy ingredients analyzed

AHD: 1-aminohydantoin
 AOZ: 3-amino-2-oxazolidinone
 AMOZ: 3-amino-5-methylmorpholino-2-oxazolidinone
 DNSH: 3,5-dinitrosalicylic acid hydrazide
 SEM: Semicarbazide

Nitrofurazone in whey protein concentrate

Nitrofuran metabolite or nitrofurazone	Samples analyzed	Samples negative	Samples positive	Average level
Nitrofurazone ($\mu\text{g}/\text{kg}$)	3	3	0	-
SEM ($\mu\text{g}/\text{kg}$)	3	0	3	2.6
AOZ ($\mu\text{g}/\text{kg}$)	3	3	0	-
AMOZ ($\mu\text{g}/\text{kg}$)	3	3	0	-
AHD ($\mu\text{g}/\text{kg}$)	3	3	0	-

- SEM detected in 3 samples of (fat-rich) whey protein concentrate
- No nitrofurazone detected
- No AOZ, AMOZ and AHD detected

Semicarbazide in different dairy ingredients

Product category	Number of samples tested	Number of samples positive for SEM	SEM range ($\mu\text{g}/\text{kg}$)
Caseinates	41	3	1.0 – 4.6
Milk protein concentrate	5	2	1.1 – 1.5
Whey protein concentrate	251	104	0.6 - 13
<70% protein	75	0	-
70-85% protein	107	56	1.0 – 8.1
>85% protein	19	15	1.0 - 13
Fat-rich	25	17	0.6 - 13
Hydrolysed	25	16	1.1 – 7.1

- SEM detected in all ingredient categories, but more frequently in whey protein concentrates
- SEM frequency of detection and levels highest in high protein and fat-rich whey protein concentrates
- No other nitrofurans metabolites detected in any ingredients

Semicarbazide formation during processing

Investigation of SEM formation during production of 3 different whey protein concentrate products

Product	Number of products tested	SEM ($\mu\text{g}/\text{kg}$) in		
		raw materials	intermediate products	dried product
Whey protein concentrate from acid whey	2	-	-	2.5 – 3.5
Whey protein concentrate from cheese whey	5	-	-	0.9 – 1.6
Whey protein concentrate – high pH (pH 10)	3	-	-	51 - 120

- SEM only detected in final dried products but not detected in raw materials and intermediate products
- SEM formation most likely occurs during (spray-)drying of the products
- No other nitrofurans metabolites detected in raw materials, intermediate product or final products

Influence of pH on semicarbazide formation in whey protein isolate

Nitrofuran metabolite	Acidic whey protein isolate (pH 3.3)			Neutral whey protein isolate (pH 6.6)		
	Frozen	2 weeks / 22°C / Aw = 0.1	2 weeks / 22°C / Aw = 0.3	Frozen	2 weeks / 22°C / Aw = 0.1	2 weeks / 22°C / Aw = 0.3
SEM ($\mu\text{g}/\text{kg}$)	0.75	0.75	1.0	4.0	4.4	15
AOZ ($\mu\text{g}/\text{kg}$)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
AMOZ ($\mu\text{g}/\text{kg}$)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
AHD ($\mu\text{g}/\text{kg}$)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

- More extensive formation of SEM in neutral than in acidic whey protein isolate
- SEM formation can continue during storage
- No other nitrofuran metabolites observed

Influence of storage conditions on semicarbazide formation in fat-rich whey protein concentrate

Nitrofuran metabolite	Water activity <0.1			Water activity = 0.3		
	2 weeks / 20°C	8 weeks / 20°C	8 weeks / 40°C	2 weeks / 20°C	8 weeks / 20°C	8 weeks / 40°C
SEM (µg/kg)	<0.5	1.0	2.3	18	37	46
AOZ (µg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
AMOZ (µg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
AHD (µg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

- Increased formation of SEM during storage of fat-rich whey protein concentrate at elevated temperature and water activity
- Similar effects observed for other whey protein concentrate types
- No other nitrofuran metabolites observed

Conclusions from experimental investigations

- SEM formation typically not observed in raw materials and intermediate products during liquid processing but only seen in powders → important role of the (spray-)drying process
- Typically, higher levels of SEM in whey protein-based ingredients than in casein-based ingredients and increased levels of SEM in ingredients with higher protein content
- Notable effect of pH on SEM formation
- SEM may also only form during storage → increased water activity of powder accelerates SEM formation during storage
- SEM is not a stable end-product



Conclusions on semicarbazide in milk protein ingredients



Key questions to be answered by the investigations

1. Does semicarbazide occur in dairy ingredients?
2. Is the occurrence of semicarbazide in dairy ingredients due to the use of nitrofurazone?
3. What are the main factors contributing to process-induced semicarbazide formation in dairy products and ingredients?
4. What are mitigation actions to minimize process-induced semicarbazide formation in dairy products and ingredients?



Conclusions

Does semicarbazide occur in dairy ingredients?

- Yes, semicarbazide is sometimes found in dried dairy ingredients
- Semicarbazide found more frequently in whey protein concentrates than in milk powder, milk protein concentrate and caseinate

Conclusions

Is the occurrence of semicarbazide in dairy ingredients due to the use of nitrofurazone ?

- No, semicarbazide found in dairy ingredients is not due to the use of nitrofurazone because:
 - No other nitrofuran metabolites found in dairy ingredients
 - No nitrofurazone found in dairy ingredients containing semicarbazide
 - Semicarbazide only found in final (dried) products but not in raw materials or intermediate products
- Semicarbazide found in milk protein ingredients is the result of process-induced formation

Conclusions

What are the main factors contributing to process-induced semicarbazide formation in dairy ingredients?

- From experimental investigations and literature research, the following factors, alone or in combination, were identified to contribute to process-induced semicarbazide formation:
 - A high product pH
 - The presence of hypochlorite
 - The presence of urea
 - (Spray-)drying
 - Storage at elevated temperature or humidity
- These factors were not found to contribute to formation of any other nitrofurans metabolites

Conclusions

What are mitigation actions to minimize process-induced semicarbazide formation in dairy products and ingredients?

- From experimental investigations and literature research, the following mitigation actions, alone or in combination, were identified to minimize process-induced semicarbazide formation:
 - Avoid high pH of products where possible
 - Ensure adequate rinsing after use of hypochlorite
 - Ensure that products are sufficiently dried and avoid storage at elevated temperature and humidity where possible
- These mitigation actions are already widely employed in good manufacturing practices for the manufacture of dairy products and ingredients

02 February, 2024

Semicarbazide and other nitrofuran metabolites in milk protein ingredients

A report prepared by the EDA/EWPA Task Force on Semicarbazide in Dairy
Products and Ingredients



EDA/EWPA Task Force on Semicarbazide in Dairy Products and Ingredients

Task force members:

- Kinga Adamaszwili (EDA/EWPA, Belgium)
- Justin Bendall (Fonterra, New Zealand)
- Diane Durand-Reville (Savencia, France)
- Thom Huppertz (FrieslandCampina, The Netherlands)
- Ove Jensen (Arla Foods Ingredients, Denmark)
- Christian Kastrup (Danish Agriculture and Food Council, Denmark)
- Nicolas Marechal (Savencia, France)
- Mirka Marescot (Euroserum, France)
- Anna Kousholt (Fonterra, The Netherlands)
- Colin Ray (Arla Foods Ingredients, Denmark)
- Geertje van der Rijdt (FrieslandCampina, The Netherlands)
- Peter Skou (Arla Foods Ingredients, Denmark)

Outcomes of EU COM meeting 18 March

- As regards whey and milk protein concentrates, caseinates and milk powder (excluding infant formulae and follow-on formulae), the presented information was considered as sufficient.
- The Commission shall now prepare an amendment to Regulation (EU) 2019/1871 with keeping the exemption for already listed products (*expected publication November 2024*).
- The Commission shall also prepare a mandate for EFSA for a specific scientific opinion on the risks for human health of SEM as a processing contaminant, in view of setting a specific maximum level for SEM as processing contaminant in relevant foods.



Future steps and research needs



Future steps and research needs


- Continued monitoring of semicarbazide and other nitrofurans markers in dairy products and ingredients
- Continued implementation of additional mitigation actions to prevent or minimize process-induced formation of semicarbazide in dairy products and ingredients
- Publication of research findings in peer-reviewed scientific paper(3)
- Presentation of findings at:
 - *EFSA Stakeholder Discussion Group on Emerging Risks (StaDG-ER; June 13 and 14, 2024)*
 - *International Whey Conference (September 2024)*
- Continued studies for mechanistic understanding of process-induced formation semicarbazide in dairy products and ingredients



Thank you

European Dairy Association/ European Whey Processors Association
Av. d'Auderghem, 22-28, 1040 Brussels

 @EDA_Dairy

 <https://eda.euromilk.org/home.html>

