Residues in milk – update on progress and ongoing challenges

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Introduction

- The demand for dairy products is increasing – challenge of increasingly stringent quality standards
- Ireland’s dairy industry
  - a high value
- Now worth > €5 billion/year - in dairy product, ingredients and nutritional exports
- Irish dairy products - exported to more than 150 markets
- International markets (beyond the EU) increasingly important
  - now constitute ~50% of Irish dairy exports
- The dairy sector - dynamic, and whatever the future holds for consumer trends and markets - quality will be foremost
Focus on residues - chlorine

- Milk quality – different parameters
- SCC
- Focus on residues
- Particularly residues emanating from use of chlorine/ chlorine containing products

- Chlorine
  - effective product for use as a disinfectant of milk contact surfaces
  - hygienically effective and cost efficient

- Two residues of concern
  - Trichloromethane (TCM) and Chlorate

  - TCM levels now largely controlled – need to be maintained, reduced further depending on market requirements
  - Chlorate: residue of recent importance – needs to be eliminated
Trichloromethane (TCM)

- TCM is a by-product of the disinfection process when chlorine is used to clean milk contact surfaces
  - At farm or processing plant level
- If milk is not rinsed from the surface before the chlorine product is used
- Chlorine (in the product) binds to the milk - total organic chlorine
- Accumulates in fat portion of milk and fat rich products, cream and butter

- Concern about TCM having some carcinogenic properties
  - Target level in butter = 0.024 mg/kg butter
  - Target level in milk = 0.00124 mg/kg milk

- Germany is currently one of the most important export markets for Irish butter
- Much competition
- TCM specification for products must be met
1. Independent testing of cleaning products

2. Established a routine test to measure milk TCM

3. Identified potential sources of TCM at farm level – during the washing /cleaning of milking plant and bulk tank
   ➢ Main issues: Detergent product type, usage, degree of rinsing

4. Recommendations and checklist
   ➢ Significant input: milk quality advisors, dairy farmers

5. Identified potential sources of TCM at processing plant level – during cleaning of equipment used in butter-making
>40,000 samples – 0.00104 mg/kg milk in 2020
TCM in butter – the journey

Targets
- Initially - 0.03 mg/kg
- 2019 - 0.024 mg/kg
Chlorate

- Chlorate is formed as a by-product during storage of cleaning/disinfection products that contain chlorine; the chlorine deteriorates during storage and chlorate is formed.
- Food safety concern: particularly in relation to chlorate development in milk and subsequently milk powder, used as an ingredient to the infant milk formula product.
- Chlorate is a competitive inhibitor of iodine uptake in the thyroid; could represent a significant health issue for vulnerable groups, e.g. those with some iodine deficiency, the foetus, individuals with low iodine intake.

Target
- Current maximum residue limit is 0.01 mg/kg
Factors influencing chlorate formation include:
- concentration, product storage time, temperature and pH

Chlorate residue can subsequently be introduced to the milk system through usage of the product for:
- cleaning milk contact equipment on-farm or in the processing plant
- chlorination of water in the processing plant

Cleaning of milk contact surfaces - chlorate residue will depend on:
- the level of chlorate formed in the stored chlorinated cleaning solution
- the efficiency of removal of chlorate residues during the rinsing cycles after disinfection

Chlorination of water
- industry is now moving away from chlorinated solutions for water treatment
- widespread adoption of chlorine gas treatment
Chlorate occurrence

Preliminary study: milk samples taken monthly (Mar-Oct) randomly selected from 7 processors (measured at Teagasc Ashtown by HPLC and induction coupled MS methodology)

Only 3% of all samples tested (1,530) exceeded the MRL for chlorate (0.01 mg/kg)
Removal of all chlorinated products

• Low occurrence – but product safety critical
• Requirement to reduce further/ eliminate chlorate to:
  • enhance the market perception of Irish products and
  • protection of markets IF the MRL was reduced further
• Recommendation for complete removal of all chlorinated products to be used for cleaning of milk contact surfaces on-farm and within processing sites since January 2021

• BUT MUST ENSURE THE ABSENCE OF ANY NEGATIVE IMPACT ON MICROBIOLOGICAL FOOD SAFETY

• Now – chlorine products removed - remaining source of potential chlorine contamination is through public water supplies
• Need to investigate if public water supplies impact on chlorate levels in the dairy chain
• Also relevant to TCM levels in milk
To ensure the safety of public water supplies, water needs to be disinfected for the end user.

Preferred approach is generally chlorination.

>90% of public water supplies are chlorinated in many developed countries.

But chlorate development is a function of chlorine concentration, storage temperature, time and pH and could be passed on to the chlorinated water.

Focus on water sources – can public water supplies potentially contribute to chlorate and/or TCM levels in milk.

Currently engaging with water treatment authorities.

Initiating on-farm studies examining:
- TCM levels in water and milk samples
- Chlorate levels in water and milk samples
Potential alternative residues from chlorine-free cleaning products

- Chemical manufacturers currently expanding the range of new 'chlorine-free' products
- Confidentiality (for competitive purposes) – full knowledge on all ingredients of these new cleaning products may not be available
- Residue can arise due to:
  - physical presence of product residue
  - combination of a component/ingredient of the cleaning product with a milk component
- Potential risk of a new and unintentional residue
- New programme commencing in this area
  - A range of ‘chlorine free’ detergents will be analysed
  - Spectroscopic testing of detergent products will be conducted to determine the constituents and possibilities for residues
- International Dairy Federation (IDF) Working Group have now prioritized examination of compounds, e.g. Organic acids, QACs (quaternary ammonium compounds), Phthalates
The risk of chlorine residues has largely been eliminated from the dairy supply chain.

Chlorine-free cleaning is in place.

BUT must maintain ongoing vigilance regarding the emergence of potential residues:

- contributed from public water supplies or
- from the use of replacement (for chlorine) or other products.
Thank you