


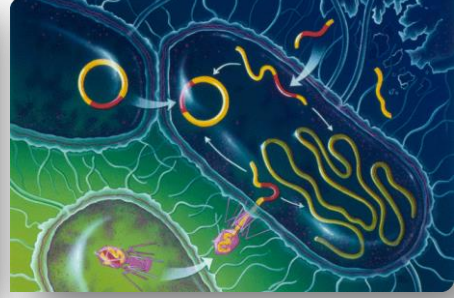

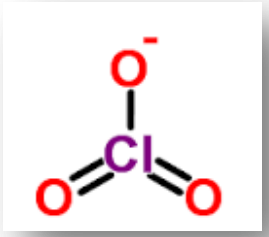


Teagasc
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# Chlorates Presentation (Based on Industry Data)

## Effect of Dairy Processing Unit Operations

# Overview

1. Chlorate Levels (ppb) Reported in the Irish Dairy Processing Industry
2. Industry Data from Water Supply's (including Process water)
3. Impact of Process Unit Operations on Chlorate Levels
    1. Review of the data from Irish Dairy processing plants
    2. Gaps in the Knowledge
4. Summary / Key Points / Questions

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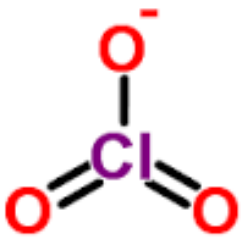


# 1. Levels Chlorate (ppb) Reported in the Industry

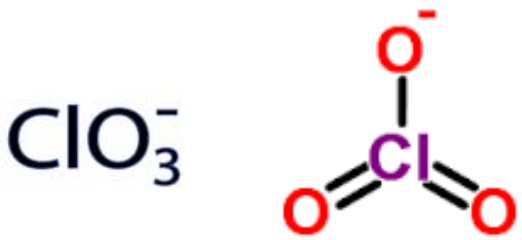
**Range of Chlorate levels found in different products**

Milk: <10 – 60 (variability high)
Skim (powder): 70 – 800 ppb
WPC35: 200 – 800 ppb
Lactose: <20 ppb
Curd washing can increase Chlorate content

**Typical Specification as set by IMF company's**

50 ppb in skim milk powder
50 ppb in whey powders

<20 ppb in lactose



# 2. Industry Data from Water Supply Sources

## Dairy Processor 1

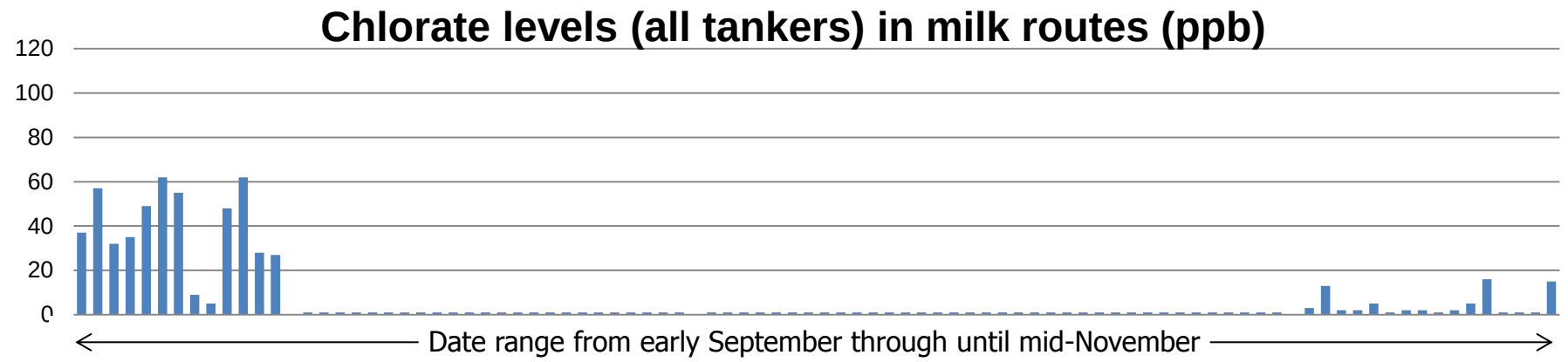
| MAINS WATER | | | |
|---|---|---|---|
| **Sample** | **Date** | **Chlorate mg/l** | **PPB** |
| Mains Water | 10/04/2015 | 0.169 | 169 |
| Mains Water | 08/06/2015 | 0.246 | 246 |
| Mains Water | 25/09/2015 | 0.084 | 84 |
| Mains Water | 14/10/2015 | 0.15 | 150 |
| Mains Water | 24/11/2015 | 0.17 | 170 |
| Mains Water | 13/01/2016 | 0.071 | 71 |
| Mains Water | 13/01/2016 | 0.059 | 59 |
| Mains Water | 14/01/2016 | 0.074 | 74 |
| Mains Water | 26/01/2016 | 0.1 | 100 |
| | | **AVERAGE** | **125** |
| | | | |
| **MUNICIPAL WATER SUPPLIES** | | | |
| **Sample** | | **Chlorate mg/l** | **PPB** |
| Town | ClO2 | 0.135 | 135 |
| Town | Chlorine Gas | <0.01 | <10 |
| Town | Chlorine Gas | <0.01 | <10 |
| | | | |
| | | | |
| **HYPOCHLORITE SOLUTIONS** | | | |
| **Sample** | | **Chlorate mg/l** | **PPB** |
| Activox 50 | | 533 | 533,000 |
| 5% Hypochlorite | | 1080 | 1,080,000 |
| Bulk Chlorus Tank | | 97900 | 97,900,000 |

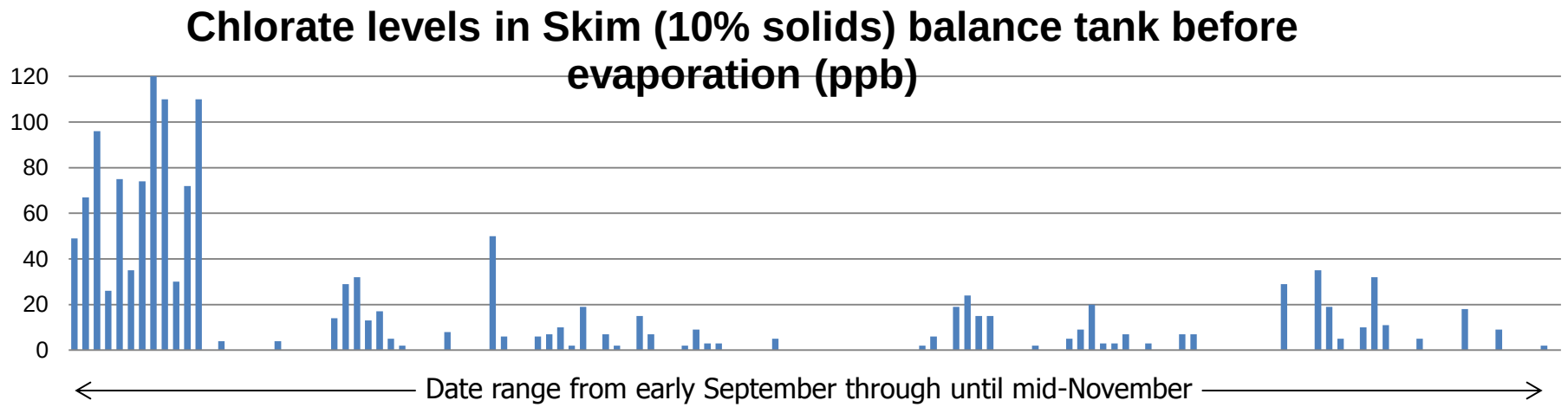
Significant reduction in chlorate levels by optimisation of chloride dioxide system (levels still between 20 – 200 ppb)

Well water negative for chlorates prior to treatment

Following treatment with sodium hypochlorite chlorate - levels were high

# 3. Impact of Process Operations on Chlorate Levels



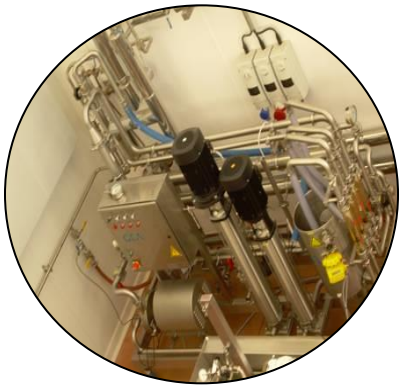



# Effect of Process Unit Operations on Chlorate levels in WPC35 and SMP

| Effect of Concentration Througout Processing on Chlorate levels | | | | |
|---|---|---|---|---|
| **WPC35** | | **mg/kg** | **ppb** | **Typical TS** |
| WPC35 | Pre-Evap Concentrate | 0.056 | 56 | 12% |
| WPC35 | Post Evaporator Concentrate | 0.23 | 230 | 38-40% |
| WPC35 | Powder | 0.8 | 800 | |
| | | | | |
| **SMP** | | | | |
| Skim Silo | | 0.019 | 19 | |
| Skim Milk Pre-Evap | Ex Silo | 0.023 | 23 | 8-9% |
| Skim Milk Post Evap | Ex Silo | 0.11 | 110 | 51-52% |
| Skim Powder | Ex Silo | 0.23 | 230 | |
| | | | | |
| Skim Milk | Ex Silo | 0.024 | 24 | 8-9% |
| Skim Milk Post Evap | Ex Silo | 0.13 | 130 | 51-52% |
| Skim Powder | Ex Silo | 0.25 | 250 | |

Need to consider the contribution of Chlorates from the process water!

# 4. Summary / Key Findings



- Raw Milk (data variable)
- Levels in Whey / Skim > than lactose
- Skim Milk
  - Increased levels found in evaporator balance tank with one company?
  - Evaporator: increases in chlorate content (concentration effect)
  - Spray dryer: increases in chlorate levels (concentration effect)
    - first powder of the dryer significantly higher in chlorates (chlorates deposited on the dryer during start-up)
    - Dairy processor 3 found chlorates in powder higher than concentrate?
- Chlorine Gas produced lowest levels of Chlorates
  - Reduced levels during processing (Process water, Flush water, Push water, CIP water)
- Sodium hypochloride led to increased chlorates levels

# Possible Follow-ups

- Risk analysis on all product / water interfaces
- Independent validation of Chlorates methodology on different dairy ingredients / concentrations (using same instrument / set-up)
- Kinetics of Chlorate formation vs in-process temperature/time combination
- Experiments to understand variation between powder and liquid samples
  - The matrix effect (skim vs whole milk; concentrate vs. powder)
  - The extraction procedure
- Controlled experiments to test the effect of the spray dryer on chlorate formation
  - Evaporator / Pilot dryer; Chlorate minimised CIP
  - High solids mix (no evaporation) run to test the dryer
  - Concentrate (freeze dried) vs. powder (reconstituted back to the same solids)
  - Dried with and without nitrogen injection (reduced Oxygen); De-aerated.
- Effect of concentration in whey products; controlled experiments with RO / deionised water; demineralisation; standardisation; pH (especially de-Min); Ion exchange (HCL, NaOH and/or NaCl used as regenerants).