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Application:

The findings of this laboratory based experiment suggest that waters with increasing total chlorine levels will have increased chlorate levels and should that water come into contact with milk it has the potential to cause chlorate contamination of said milk. This study provides the information needed to design targeted field based experiments that are required to establish the trends and behaviours of chlorate in water when used as part of the cleaning process on dairy farms and its impact on milk residues and is requisite for the betterment of the dairy industry in terms of its understanding of contamination of farm bulk milk with chlorate as a consequence of chlorinated water use.

Introduction:

Chlorate; a product of chlorine degradation has emerged as a residue of concern across the international dairy industry in recent years due to its goitrogenic health implications and the subsequent effect that this has on market demand. Chlorine based chemicals used for cleaning milk contact surfaces are viewed as being a primary source of chlorate contamination in milk. In addition to this, chlorinated water is also mooted as a potential cause of chlorate residue in milk where it is used as part of the milking equipment cleaning routine (McCarthy et al., 2018).

Materials and Methods:

To establish if water containing chlorine results in chlorate residue in milk, a laboratory experiment was conducted where 24 test samples were created using chlorine free well water and an 11% sodium hypochlorite product in batches of 6; at 4 different time points over a 6 month period in 2021; with waters chlorinated to achieve the following levels in each batch; 0.50 mg/L, 1.00 mg/L, 1.50 mg/L, 2.00 mg/L and 2.50 mg/L of total chlorine respectively (non-chlorinated well water was the control). These waters were frozen, defrosted and analysed for chlorate in triplicate. These same waters were then used to spike 24 individual 100 ml milk samples at a rate of 2%; followed by inversion, freezing at -20°C and chlorate analysis (when defrosted). Both waters and milks were analysed for chlorate using ultra performance liquid chromatography coupled with tandem mass spectrometry with a minimum level of detection of 0.00020 mg/L and 0.0020 mg/kg respectively.

Results:

Increasing levels of chlorate were displayed ranging from 0.0021 mg/L to 0.68 mg/L in the waters; increasing in line with chlorine concentration and sodium hypochlorite age. The spiked milks displayed increasing levels of chlorate ranging from <0.0020 to 0.013 mg/kg; similar to the trend displayed by water chlorate levels.

Conclusions:

The presence of chlorate at detectable levels in spiked milks indicates that chlorate in water can result in chlorate contamination of milk when both water and milk make direct contact. Furthermore, this study suggests that water containing higher levels of chlorate poses a greater risk to milk as it will likely result in greater levels of chlorate contamination. Further investigations are needed at farm level to determine the practical impacts that chlorate in water has on chlorate in milk where it is used as part of the milking equipment cleaning regime.

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References:

McCarthy, W.P., O'Callaghan, T.F., Danahar, M., Gleeson, D., O'Connor, C., Fenelon, M.A. and Tobin, J.T., (2018). Comprehensive reviews in food science and food safety, 17(6), pp.1561-1575.