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Optimum milk quality focusing particularly on chemical residues

Key external stakeholders:

Dairy farmers, Milk processors, Export markets, members of veterinary profession

Practical implications for stakeholders:

- The Dairy industry (milk producers and processors) and Teagasc, Moorepark have worked in collaboration since 2007 to identify and develop strategies for trichloromethane (TCM) residue reduction in milk and butter. A reduction in average milk values from 0.007 to 0.003 means that Irish butter exports will continue to compete favourably on the German market;
- Both dietary iodine supplementation and teat disinfection iodine individually result in milk iodine levels exceeding common target values of 250-300µg/kg. Both iodine treatments can frequently occur simultaneously on farm, thus supplementations should be monitored, particularly in light of infant feed formula manufacture;
- Traces of active ingredients of some flukicide products will migrate from whole milk to skim milk powder. Therefore it is important that research be conducted to establish MRLs (maximum residue limits) in milk and dairy products, for the active ingredients in animal treatment products (e.g. flukicides) to ensure (a) avoidance of risk to public health and (b) prevention of animal health issues by allowing use of effective products (some have been banned due to the absence of an MRL).

Main results:

- Milk TCM levels have been reduced to 0.002 mg/kg in milk in 2011, i.e. the target level in milk that ensures TCM never exceeds 0.03 mg/kg in the butter product. These low levels have to be maintained in the long term;
- Supplementation of dietary iodine at 30 and 70 mg/day significantly increased mean milk iodine concentrations from 208µg/kg to 672 and 733µg/kg, respectively. Teat disinfection post-milking and pre- + post-milking significantly increased the mean iodine concentration from 219µg/kg to 475 and 670µg/kg, respectively;
- Between 95% and 98% of Nitroxynil (active ingredient in flukicide product) migrated from whole to skim milk. The remainder was within the cream. When skim milk was converted to skim milk powder, almost 100% of Nitroxynil was transferred into the powder.

Opportunity / Benefit:

These results may be used by (i) dairy farmers to improve their milk quality on-farm, (ii) milk quality advisory personnel to solve milk residue issues on-farm and (iii) bodies such as DAFM and IDB in promoting dairy products for the export market.

Collaborating Institutions:

Cork Institute of Technology, Bishopstown, Cork.

Contact Bernadette O'Brien Email: Bernadette.Obrien@teagasc.ie.

Teagasc project team: Dr. Bernadette O'Brien (PI)
Dr. David Gleeson
Dr. Kieran Jordan
Dr. Martin Danaher
Dr. Riona Sayers
External collaborators: Dr. Ambrose Fury, Cork Institute of Technology

1. Project background:

TCM - Cleaning and disinfection in the milk production process on-farm is critically important to the quality of milk. Chemical solvents containing chlorine are among the most effective and economical, but there is an unintentional side effect: when chlorine comes in contact with milk, trichloromethane (TCM) is formed resulting in residues, particularly in high fat products. There are both legal limits and recommended target levels for TCM in specific dairy products.

Iodine - Iodine supplementations at farm level tend to be used in the expectation of increasing cow health and fertility. There is concern that such practices may result in high milk iodine which could affect ingredients for infant formula particularly, and thus, export markets.

Flukicides - Nitroxynil is an active ingredient in the veterinary product *Trodax* used to treat liverfluke in cattle. While this product is currently not recommended for use in lactating cows due to residues in milk, little information is available about the transfer of active ingredients such as Nitroxynil to milk products.

2. Questions addressed by the project:

TCM – to develop a strategy to resolve the TCM residue issue on a relatively small number of farms and establish if that strategy could then be applied successfully to a relatively large group of farms

Iodine – to quantify the effect of iodine supplemented concentrate feed and teat disinfection practices on milk iodine concentrations of dairy cows.

Flukicides - to establish the stability and persistence of Nitroxynil in the manufacturing process and product of milk powder.

3. The experimental studies:

TCM - a template procedure was developed, tried and tested on 43 farms. This involved identifying farms with high TCM milk, applying advice and recommendations to reduce TCM and re-measuring milks from these farms. (TCM in milk was measured by head-space gas chromatography with electron capture detector.) This strategy proved successful in significantly reducing milk TCM in the three geographical regions tested, e.g. TCM was reduced from 0.006 to 0.002 mg/kg ($p<0.05$). This strategy was then applied to farms who supplied milk to six Irish dairy processors with the objective of reducing TCM in those milks to the marketing acceptable limit of 0.002mg/kg.

Iodine – Thirty lactating cows were fed 7 kg, 3 kg and 0 kg meal (10 mg iodine/kg) during 3 periods of 14 days each. During each subsequent 7 day period, 1 of 3 teat disinfection treatments was applied to each of 3 cow groups (n=10): non-iodine post-milking; 0.5% iodine post-milking; 0.5% iodine pre- and post-milking. Cow milk yield was 21.3 kg/day. Individual cow milk samples were taken for iodine analysis on 2 milking days at the end of each treatment period.

Flukicides - Six dairy cows were treated, during lactation, with 1.5ml TRODAX® (which contained Nitroxynil 34%) / 50kg bodyweight. Samples were collected twice daily for 28 days post treatment and frozen at -20°C The samples were thawed at 4°C and pooled into 6 independent aliquots, each containing milk from each of two, 3 cow groups on Day 1-9 (P1), Day 10-15 (P2) and Day 16-28 (P3). Each aliquot was separated into skim milk and cream and the skim milk was processed to milk powder using a laboratory scale spray drier. The cream, skim and powder from each sample were then analysed for Nitroxynil using mass spectrometry.

4. Main results:

TCM – Initially, milk tankers containing milks from approximately 10-15 individual farms were sampled and analysed and tankers with high TCM (>0.002 mg/kg) identified. Individual herd milks contributing to these tankers were subsequently sampled and analysed and farms supplying high TCM identified. Guidance and advice was provided to these high TCM milk suppliers and changes in the levels of TCM of these milk supplies were monitored subsequently. A significant reduction (minimum $p<0.05$) in milk TCM was observed

Contact Bernadette O'Brien Email: Bernadette.Obrien@teagasc.ie.

in 5 of the 6 dairy processor milks (e.g. 0.007 to 0.002 mg/kg), while a numerical reduction in TCM was observed in the remaining processor milk.

Iodine – The iodine content of the milks from treated cows reflected iodine supplementation in the feed. Supplementation of dietary iodine at 30 and 70 mg/day significantly increased mean milk iodine concentrations from 208µg/kg to 672 and 733µg/kg, respectively ($p<0.05$). A human daily intake of 300g of milk from cows consuming 3kg concentrate with 10mg iodine/kg would supply an adult with 185 µg iodine (recommended daily requirement). The iodine content of milk also reflected iodine disinfection practises. Teat disinfection post-milking and pre + post-milking significantly increased the mean iodine concentration from 219µg/kg to 475 and 670µg/kg, respectively ($p<0.05$).

Flukicides - Nitroxinal levels in the milk decreased during the experimental period. All the Nitroxynil was recovered during the separating process between skim and cream. Between 95% and 98% of the Nitroxynil migrated from whole to skim milk. The remainder was within the cream. Average concentrations of Nitroxynil in the skim milk and cream fractions were 555.1 µg/1.2 litre and 9.0 µg/37 ml and 15.9 µg/1.1 litre and 0.44 µg/44 ml in Periods 1 and 3, respectively. When skim milk was converted to skim milk powder, almost 100% of Nitroxynil in skim milk was transferred to the powder product, for example, 15.3 µg of Nitroxynil was recovered in the skim milk powder in Period 3. This occurred despite the high temperatures used during the manufacturing process (spray drier inlet temperature of 185°C ± 2°C and an outlet temperature of 90°C ±2°C.

5. Opportunity/Benefit:

TCM - this study (i) proved the concept that a milk quality problem may be resolved on a relatively small number of farms by dissemination of information and implementation of corrective action on-farm, accompanied by repeated sampling and analysis of milk samples together with continuous feedback of the results to the milk supplier, and (ii) that this strategy can be applied successfully to a relatively large group of farms. The transfer of information to dairy farmers took a number of different forms; visits to considerable proportion of farms by milk quality personnel, newsletters, Teagasc guidelines, written communications from the milk processor to individual dairy farmers and newspaper campaigns represented the most popular methods. It is suggested that the strategy developed and applied and found to be successful in solving the TCM problem on these farms could also be applied and could be successful in resolving other milk quality problems on-farm.

Iodine – The iodine in the treatment milks reflected feed supplementation with iodine. The study confirmed studies in the literature indicating the transfer of iodine from feed to milk. It may be possible to further reduce maximum iodine levels in feed. However, this would need to be done in association with feed manufacturers and members of the veterinary profession. Pre-milking disinfection can pose a substantial risk of iodine transfer to milk, as it is dependent on the degree of removal from the teats prior to cluster attachment. This practice should be reserved for extreme situations or problem farms where milk somatic cell count is high. It is important to continuously monitor the National milk iodine level. This is particularly important in winter milk production when both iodine supplemented feed and iodine disinfection are widely used. With a requirement for maximum milk iodine levels of 250 µg/kg for some products, there is little flexibility available. This study indicates the contribution of different iodine supplementations to milk iodine, so the information generated may be used to maintain milk iodine levels within the required limit.

Flukicides - The results showed that residues of nitroxynil will be present in milk after administration, will be partitioned with the skim-milk and will be present in a subsequent powder product. Thus, sufficient caution must be exercised with regard to withdrawal periods to ensure avoidance of risk to public health. Also, this research is important as it is only with an accumulation of similar data for other active ingredients that a database can be set up that will provide data for MRLs to be applied to different products. This is necessary so that appropriate products (e.g. other flukicides) may be defined as safe and allowed to be used for the betterment of health of lactating cows.

6. Dissemination:

Mainly through newsletters, Teagasc guidelines, Teagasc open days, written communications to Advisory groups and individual dairy farmers and newspaper campaigns and very importantly, 'Milk Quality Workshops' for technical personnel working at different levels of the dairy industry, e.g. as follows:

O'Brien , B. (2011). TCM in milk. In: Milk Quality Forum (Symposia), Moorepark, 22-Mar-2011.
O'Brien , B. (2011). Flukicides in milk. In: Milk Quality Forum (Symposia), Moorepark, 22-Mar-2011.
O'Brien , B. (2011). Iodine in milk. In: Milk Quality Forum (Symposia), Moorepark, 22-Mar-2011.

Contact Bernadette O'Brien Email: Bernadette.Obrien@teagasc.ie.

Main publications:

Power, C., O'Brien, B., Danaher, M., Furey, A., Bloemhoff, Y., Sayers, R and Jordan, K. (2001). Residue concentrations of Nitroxynil in milk and product following administration to cows. In: *Proceedings of the 62nd annual meeting of the European Association for Animal Production*. Stavanger, Norway, 29th August – 2nd September, pp.315.

O'Brien, B, Jordan, K. and Gleeson, D. (2010). Effect of dietary iodine and teat disinfection iodine on milk iodine levels. *Proceedings of International Dairy Federation Congress*. Auckland, NZ. 8-11 November, 2010.

Ryan, S., Gleeson, D., Jordan, K.N., Furey, A. and O'Brien, B. (2011). Reducing trichloromethane levels in milk. In: *40th Annual UCC Food Research Conference*, UCC, Cork, 31-Mar-2011, p. 51

Popular publications:

O'Brien, B., Gleeson, D. and Ryan, S. (2011). *Irish Farmers Journal*, 15th January, 2011. Milk Quality Supplement.

O'Brien, B., Jordan, J. and Gleeson, D. (2011). Reducing trichloromethane (TCM) levels in milk. *Moorepark News*, Winter, 2011.

O'Brien, B., Sayers, R. and Jordan, K. (2010). Caution required in the use of flukicides. *Irish Farmers Journal* 9/12/10.

7. Compiled by: Dr. Bernadette O'Brien

Contact Bernadette O'Brien Email: Bernadette.Obrien@teagasc.ie.