SOLID participatory research from UK: Reducing antibiotic use for mastitis control in organic dairy farms

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Summary

To reduce the use of antibiotics in organic livestock production, the EU-Regulation (EC/834/2007) postulates that "homeopathic and phytotherapeutic remedies shall be used in preference, provided that their therapeutic effect is effective for the species of animal and the condition for which the treatment is intended". This study presents data from on-farm trials on the effectiveness of a liniment mint oil cream in reducing somatic cells counts in organic dairy cows.

In the UK, treatment of mastitis incidences in organic dairy farms relies largely on antibiotic use. To mitigate the use of antibiotic treatments for controlling mastitis in dairy cows, several farmers use a specially formulated liniment commercial cream containing 35% mint oil. The cream is designed for massage and absorption into the udder and it is used for softening swollen and inflamed udders as well as being used as an oedema preventative at calving time on organic farms. Somatic cells counts (SCC) in milk increase as a result of an immune response to a mastitis-causing pathogen. Mint oil is known to improve blood flow by dilation of the capillaries and it is likely that application of the mint oil cream can enhance the transportation of white blood cells to the udder and thus, can act as a prophylactic measure to prevent mastitis. Here we present results from a participatory research trial which tested the effect of a commercial liniment cream containing 35% mint oil on SCC, following treatment of the udder.

Farmer group meetings were held quarterly during 2013 and 2014 allowing for knowledge transfer about the application of the liniment mint oil cream and communication of potential benefits. To test whether the use of liniment milt oil cream can maintain cows' SCC at optimum levels in practice, six farmers committed to -but only four succeeded in- participating in an on-farm trial during 2014. According to the experimental protocol, every second newly-calved cow was treated for 4 consecutive days with the commercial liniment mint oil cream (Uddermint®). Somatic cell count (SCC) data derived through National Milk Records were compared to data from untreated cows (control). When farm data were combined for each monthly recording, SCCs of the treated cows were systematically lower compared to those of the untreated cows; combined farm data across the recordings showed that the overall SCCs of the treated cows were significantly lower ($P=0.04$) compared to those of the untreated control cows. It is concluded that liniment mint oil cream treatment could act as a complementary on-farm practice to prevent mastitis incidences as indicated by the cows' SCC, but the mode of action remains to be investigated.

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1 Aims and Research question

The aim of this study was to evaluate the effectiveness of a commercial liniment cream containing 35% mint oil in reducing cows' somatic cell counts, as an alternative practice to the use of antibiotics on organic dairy farms.

2 Background

2.1 Farmers' background

There is a great interest amongst dairy farmers in reducing the use of antibiotics on their farms and the level of antibiotic use for the control of mastitis is of particular concern. The Field Lab programme "Duchy Originals Future Farming Programme", organized by the Soil Association with participation of the Organic Research Centre (the ORC) provided an ideal framework to form a discussion group and thus, a proposal to create a local farmer group focusing on antibiotic reduction in dairy herds was put forward. The farmers involved were keen to improve the health of dairy cows with the aim of cutting down on antibiotic use, with benefits for animal welfare and farm profitability as well as contributing to efforts to preserve antibiotics for life or death situations. The farmers met on a regular basis and the meeting was held at a different farm each time, giving the opportunity to the host farmer to share current issues, problems and production data and benefit from other farmers' feedback on cow health, herd management and mastitis treatment.

The main focus of the discussion group was to share experience and management practices regarding the use of a commercial liniment cream containing 35% mint oil (Uddermint®) as an alternative or complementary approach to the use of antibiotics to treat mastitis on organic dairy farms. Some of the participating farmers were using this practice as standard farm management while others were keen to explore or to question the potential benefits. Consequently, the farmers identified the need to gather more robust data on the effectiveness of the use of Uddermint® in containing cows' somatic cell count (SCC) and six farmers committed to -but only four succeeded in- participating in an on-farm trial during 2014. The meetings were co-ordinated by a livestock consultant from the Farm Consultancy Group, UK while the set-up of the on-farm trials was formulated with input from a livestock researcher from the ORC.

2.2 Research Background

2.2.1 Mastitis of dairy cows

Bovine mastitis is the inflammation of the mammary gland and udder tissue and is one of the main animal health problems both in conventional and organic dairy herds (Hovi et al. 2003; Ruegg, 2008; Haskell et al., 2009). It usually occurs due to bacterial invasion into the teat canal but also can occur as a result of chemical, mechanical, or thermal injury to the cow's udder.

In clinical cases of mastitis the cow displays definitive symptoms of the disease, mainly associated with abnormalities in the udder (i.e. swelling, heat, hardness, redness, pain) and in the milk (i.e. watery appearance, flakes, clots, or pus). Other symptoms, depending upon the severity of the illness and how systemic it has become, also include reduction in milk yield, fever, anorexia, diarrhoea and dehydration. The disease can also be present in a herd sub-clinically, where the

affected cow displays few or no obvious clinical symptoms of the illness. A subclinical cow, while appearing unaffected by the illness, may experience a reduction in milk yield and certainly represents a possible source of infection for other cows, who can become subclinical sufferers themselves, or may go on to show clinical signs of the illness, due to differences in immune status between cows. Subclinical infection can only be indicated directly by a high individual cow SCC. This is because the number of somatic cells (i.e. leukocytes- white blood cells) in milk increases as an immune response to a mastitis-causing pathogen develops and a number of epithelial cells, which are milk-producing cells, shed from inside of the udder when an infection occurs. The cases of sub-clinical mastitis can be up to 40 times more common than clinical cases of the illness making mastitis a very complex disease. The presence of a causative pathogen is confirmed via a bacteriological culture and indirect indications of subclinical mastitis can be obtained via electro-conductivity testing of milk, which is performed in an automated form in many modern parlours and robotic milking systems. A threshold SCC of 200,000 would determine whether a cow is infected with mastitis. Cows with a result of greater than 200,000 are highly likely to be infected in at least one quarter.

Mastitis is most often transmitted by contact with the milking machine, and through contaminated hands or other materials, in housing, bedding and other equipment. Thus, the origin of infection is either contagious or environmental. This distinction may be important when assessing the challenges present in a herd and the measures which may be taken to reduce or treat mastitis.

Table 1. Major pathogens associated with incidences of contagious or environmental mastitis.

Mastitis - Causing Pathogens	**Type of mastitis**	**Signs**	**Response to antibiotics**
Streptococcus uberis	Environmental	very acute, with a sudden onset	particularly responsive to a range of antibiotics
Staphylococcus aureus	contagious mastitis pathogen, and has a good ability to adhere to teat and udder skin	characteristic in chronic cases	notoriously difficult to treat with antibiotics
Escherichia coli	biggest environmental cause of mastitis / being present in large numbers in faeces	very acute, painful and potentially fatal forms of mastitis	Vaccines are available, but their use is heavily compromised by the fact that several strains of the bacterium may be present
Streptococcus agalactiae *Streptococcus dysgalactiae*	very contagious mastitis / it can either give acute, febrile disease or sub-acute, more chronic disease	common cause of mastitis in heifers and dry cows and implicated in cases of Summer Mastitis.	responds well to antibiotic treatment / prophylactic treatment can prevent early-onset disease
Corynebacterium bovis:	causing subclinical disease / contagious	raised Somatic Cell Counts	sensitive to the majority of antibiotics
Mycoplasma	highly contagious		responds poorly to antibiotics
Staphylococci species	subclinical mastitis		
Coliformbacteria	environmental mastitis	severe, toxic mastitis	

In the UK, the main bacterial species that cause mastitis in dairy cattle are *Streptococcus uberis*, *Staphylococcus aureus*, and *Escherichia coli (E. coli)*, although more than 200 organisms have been

identified as mastitis-causing pathogens. The major pathogens associated with incidences of contagious or environmental mastitis are summarised in Table 1.

- Contagious pathogens that cause mastitis live on the cow's udder and teat skin and transfer from affected cow (or quarter) to unaffected cow (or quarter) during milking. They adhere easily to the skin, colonising the teat end and then 'grow' into the teat canal, where infection occurs. Farms with a high level of contagious mastitis often have high Somatic Cell Counts (SCCs) with relatively normal Bactoscan results. Subclinical infection is more likely to be caused by contagious pathogens.
- Environmental mastitis pathogens - present in the housing and bedding - can transfer during milking or between milkings, when the cow is loafing, eating or lying down. The pathogen can enter the teat canal by force during milking, for example, when liner slippage occurs. These environmental pathogens do not generally possess the same ability as contagious pathogens to adhere to and colonise the teat; dry cow therapy has little value in their control as these kinds of infections do not carry from one lactation to the next. High levels of environmental pathogens in a herd may cause normal SCCs but higher than average Bactoscan results.

The consequences of the disease and its control result in major losses to the dairy industry in the UK, and considerably impair the welfare of the dairy cow. Some of the main causes of these losses are due to milk being unsuitable for human consumption, reduction in milk yields, extra labour, costs of veterinary care and medicines and costs of reduced longevity due to premature culling.

2.2.2 Control of mastitis in organic dairy farms

Organic dairy farmers, having limited access to antibiotic treatments as the EU-Regulation (889/2008) on organic livestock production contains a restriction to only three treatments with chemically synthesized remedies per lactation. They often use alternative therapies such as homeopathy for the treatment of mastitis and adopt a more holistic approach to mastitis prevention. However, in the case of clinical mastitis the most common treatment strategy (more than 50% of the incidences) is the use of antibiotics (Vaarst et al. 2006). To reduce the use of antibiotics in organic livestock production, the Regulation postulates that “homeopathic and phytotherapeutic remedies shall be used in preference, provided that their therapeutic effect is effective for the species of animal and the condition for which the treatment is intended”. Studies from research groups in the UK and Germany show that 34–51% of clinical mastitis cases on organic farms were treated with homeopathic remedies (Hovi & Roderick, 2000; Krömker & Pfannenschmidt, 2005), although only a few papers have been published so far on using homeopathy alone as a treatment strategy in mastitis therapy and to our best knowledge none on the use of Uddermint® (see below). Clinical studies dealing with the use of alternative methods to antibiotic treatments have often been criticized for their inadequate scientific approach, e.g. for not conducting randomized clinical trials (Cucherat et al. 2000).

2.2.3 The use of liniment mint cream

Over the past years, organic dairy farmers have shown increasing interest in the use of a commercial product called Uddermint® in an attempt to mitigate the use of antibiotic treatments for controlling mastitis in dairy cows. According to the manufacturer, Uddermint® is a specially formulated liniment cream containing 35% mint oil, designed for easy massage and absorption into the udder. In organic

and low-input dairy farms this cream is used for softening swollen and inflamed udders and also as an oedema preventative at calving time. Because mint oil it is known to improve blood flow by dilation of the capillaries, it is likely that the application of Uddermint® to the udder can enhance the transportation of white blood cells (neutrophils and macrophages) to the site of infection and thus, to combat infection. However, there is a complete lack of scientific data or case studies to support this hypothesis. This study presents data from on-farm trials on the effectiveness of a liniment cream containing 35% mint oil in reducing somatic cells counts in organic dairy cows.

3 Methodology and Data Collection

3.1 Location of the Farms

Participating farms were located in south west of England (i.e. Wiltshire, Oxfordshire, Gloucestershire and Berkshire) and one farm was located in the south east (Kent).

3.2 Data collection and sampling

Each Field Lab was attended by 8 to 12 farmers or farm managers and on every occasion the meeting was held at a different farm (host farm). From September 2012 to June 2014, 8 field lab meetings occurred and a summary of the group discussions is given below in addition to the on-farm trial data.

3.2.1 Meetings 1 to 5

The initial meetings discussed the use of antibiotics on the farms and the practicalities of using Uddermint® as part of any treatment plan for mastitis in dairy cows. There was an investigative discussion with an individual group member whose herd required higher than normal amounts of antibiotics in 2011 - 12. The research identified that spring block calving herd had encountered problems during the dry period in 2012 which could have linked to the very wet, mild conditions in January 2012. Participants visited a new parlour development where the farmer is keen to trial Uddermint® in the future.

3.2.2 Meetings 6 to 8

Discussions revolved around current use of Uddermint® regarding practicalities and potential benefits as four farms were using Uddermint® to some degree already, but not under trial conditions. Some of the farmers were using it as a complementary method for mastitis treatment in the early stages, although, some were using it to treat cows with rising cell counts. However, it was too early for the farmers to report conclusively whether the strategy of treating cows with rising cell counts was working. In December 2013 six farms agreed to run a controlled field lab trial from January to April 2014 (described below). At the June meeting, the trial that was started in January had been completed and this was the first chance to review all the raw data collected. The discussion focussed on optimum drying off and *Orbeseal* application, as well as methods of barn and grazing management.

3.2.3 On-farm trial

To test whether the use of liniment milt oil cream can maintain cows' SCC at optimum levels in practice, six farmers committed to participate in an on-farm trial during 2014. According to the experimental protocol, every second newly-calved cow was treated for 4 consecutive days with the commercial liniment mint oil cream Uddermint® (treatment UT). The cream was applied in a

quantity of 5 ml and the whole udder was massaged for a minimum of 2 minutes each day before the morning milking. The control group (treatment C) consisted of untreated cows. The SCC of both UT and C cows in each farm were recorded for 4 months through National Milk Records. Data were analysed by means of a two sample t-test assuming unequal variances.

3.3 Time Scale

Farmer group meetings were held quarterly from September 2012 to June 2014 while on-farm trials took place from January to April 2014. A final wrap-up meeting was held at the ORC in November 2014.

4 Results and Discussion

Out of the six farmers committed to participate in the trial only four succeeded in carrying out the experimental procedure while two farms voluntarily withdrew from the study shortly after the start of the trial and no data were collected from these farms.

4.1 Farm differences

The number of cows included in the trial on each farm, the total SCC observations obtained and the percentage of the cows with above 200,000 or 1,000,000 SCC are shown in Table 1. As expected, due to differences in the size of the farms and farm's calving management, the number of cows included in the trial as well as the SCC observations obtained, differ from farm to farm; yet, the number of observations was sufficient to pick-up statistical differences as discussed latter.

Table 1: *Overview of the data obtained in each participating farm.*

	Farm 1		Farm 2		Farm 3		Farm 4	
Uddermint treatment:	Yes	No	Yes	No	Yes	No	Yes	No
Cows (n)	29	36	18	15	14	11	22	32
Total SCC Observations	115	142	69	58	49	42	82	117
Cows with SCC > 200*	17.4%	24.6%	17.4%	22.4%	18.4%	7.1%	19.5%	32.5%
Cows with SSC > 1000*	2.6%	2.8%	1.4%	0.0%	0.0%	2.4%	2.4%	11.1%

**Thousand*

It is mentioned earlier that cows with more than 200,000 SCC are highly likely to be infected on at least one quarter of the udder. In this respect, the data show that in Farms 1, 2 and 4 the percentage of cows with SCC > 200,000 is higher in the group of cows that were not treated with Uddermint® compared to the Uddermint® treated group, which suggests that untreated cows are prone to get mastitis infection. This notion is not supported by the data in Farm 3. The high percentage of cows with SCC > 200,000 within the Uddermint® treatment group in this Farm, is likely due to the fact that the farmer uses Uddermint® as a complementary method for mastitis treatment and deliberately selected cows with high SCC to be included in this treatment.

The average SCC over the monitoring period (i.e. 4 months following calving), in both treated and untreated cows on each farm, is shown in Figure 1. As expected, average SCC varied across the participating farms. On average, Uddermint® treated cows in Farm 3 had significantly lower SCC compared to SCC in Farms 1 and 4 (Figure 1, panel i). The same farm differences were also noted in the untreated cows, with the addition that SCC in the untreated cows in Farm 4 were significantly higher compared to all other farms. These differences do not imply any biological meaning other

than that farm differences in terms of health status are known to exist and that herd heath status is related to farm practices and herd size.

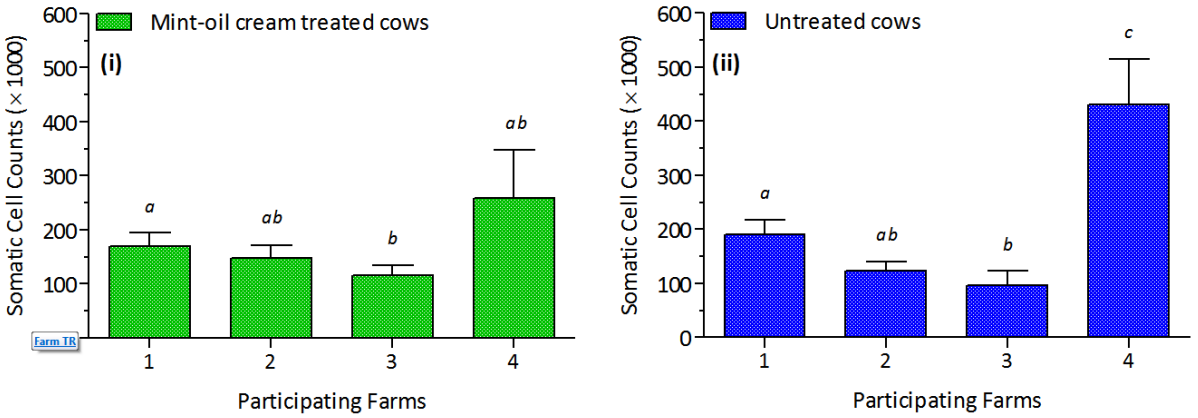

Figure 1. *Average Somatic Cell Counts per farm in Uddermint® treated [panel (i)] and untreated [panel (ii)] cows in the participating Farms (in each panel, means with different letters indicate statistical differences).*

4.2 Effects of liniment mint-oil cream treatment on SCC

Differences in SCC between Uddermint® treated and untreated cows were tested in each recording month but also on the averaged farm data over the recording period, for each farm separately. The data show that SCC in all farms were systematically lower in the Uddermint® treated cows compared to untreated cows, but, statistical differences were only observed in month 2 and 3 following calving in Farm 4 only.

In addition, SCC data from each treatment were combined across the farms for each recording month and differences between Uddermint® treated and untreated cows were tested (Figure 2a). The results show that on average, SCC in the untreated cows remained relatively constant and above the critical threshold 200,000. In all recording months SCC of the Uddermint® treated cows were lower than in the untreated cows but a statistical significant difference was noted only in the 3rd recording (Figure 2a).

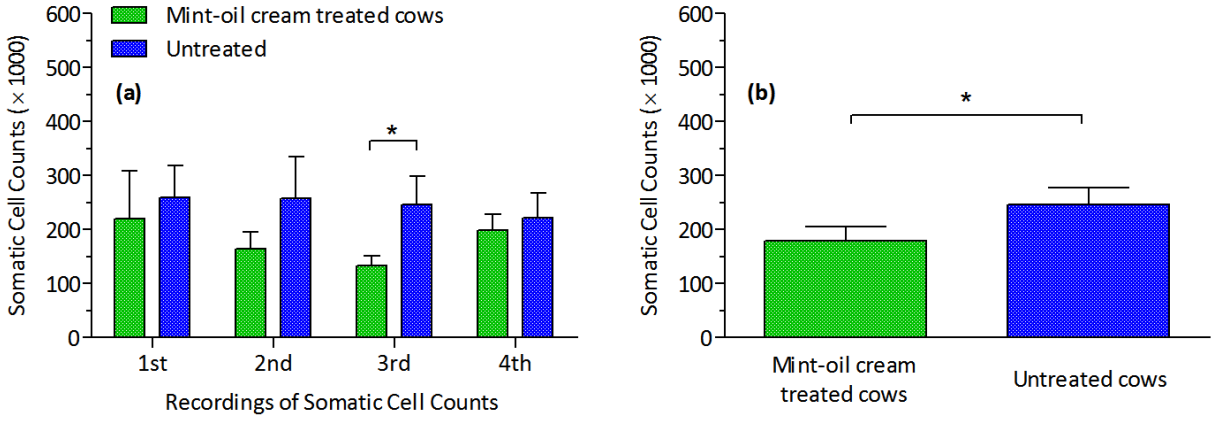

Figure 2. *Average SCC in each recording month combined across the participating farms [panel (a)] and average SCC combined over the recording periods and over farms [panel (b)] (in each panel, means marked with * indicate statistical differences).*

When SCC data from each treatment were combined across the farms and across the recording months a statistical difference between Uddermint® treated and untreated cows (Figure 2b) was observed. This indicates, also in view of the individual farm data, that treatment of the udder with a liniment cream containing 35% mint oil has the potential to reduce SCC in dairy cows.

4.3 Effect of cow lactation year and calving month on SCC

Across farms the cows included in the trial calved from February to April 2014 and the number of cows calved in each of these months in all participating farms is shown in Table 2. The cows were assigned to one of two groups based on whether the lactation year of the cows falls within year 1 to 4 or 5 to 8 (Table 2). These data enabled to test the effect of calving month on SCC in both treatments, as well as whether differences in SCC exist between the groups in terms of the year of lactation. Results of these comparisons are shown in Figure 3.

Table 2: *Number of cows in each group of lactation-year and in each calving month, in both treatments, across the participating farms.*

	Year of lactation		Calving month		
	1 to 4	5 to 8	Feb	Mar	Apr
Uddermint Treated Cows (*n*=)	209	106	96	129	90
Untreated Cows (*n*=)	237	122	155	115	89

In line with the previous findings, the average SCC in the treated cows was systematically lower compared to the mean SCC of the untreated cows, irrespective of the lactation-year-group or calving month; however, due to large variation of the SCC in each group no statistical differences were noted. The results also showed that mean SCC were not affected by the year of lactation, nor by calving month.

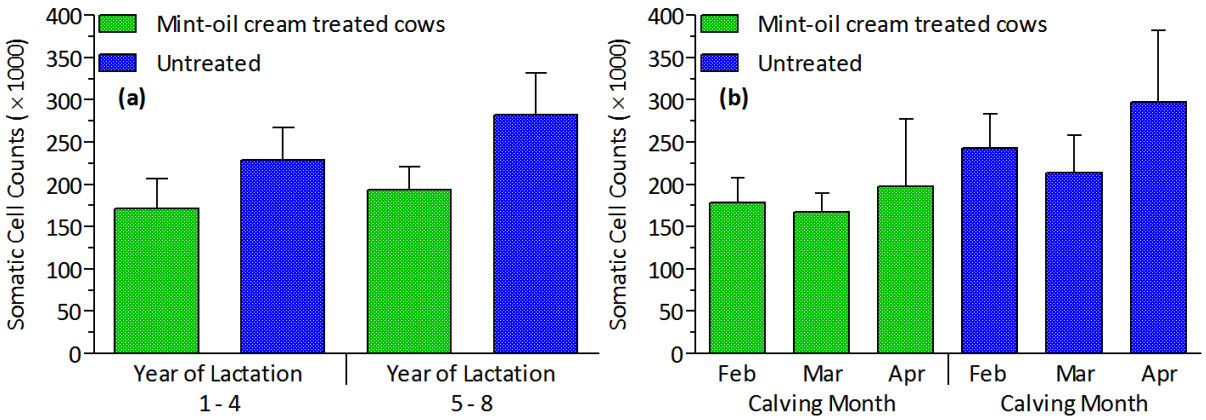

Figure 3. *Effect of year of lactation (panel a) and calving month (panel b) on SCC in mint-oil cream treated or untreated cows, across farms.*

5 Conclusions/Recommendations

Participating farmers have commented that although they considered their management prior to this discussion group and the on-farm trial was quite good, they have benefited from the process of coming together to discuss the various methodologies the other farmers employed. A farmer who uses mint-oil cream treatment as a standard practice commented that "It is difficult to pick up trends as yet [in 2013] but it has made us aware of our treatment protocols compared to other farms in the group". Although some of the farmers voluntarily withdrew from the study, the on-farm trials conducted on the four farms indicated that liniment mint oil cream treatment of the newly calved-cows could act as a complementary on-farm practice to reduce mastitis incidences as indicated by its effect on cows' SCC. Future studies will be needed to determine the mode of action as well as the optimum volume and massage duration for an effective treatment and an acceptable cost:benefit ratio to animal welfare and farm performance.

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