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# The Treatment of Cattle Slurry on Farms with *Brucella abortus* Infected Herds

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## Introduction

Brucellosis is a problem in cattle herds in parts of Ireland, particularly in the south and south west. Recently, further emphasis has been placed on the management of cattle manure, particularly slurry, on affected farms in addition to other control measures to minimise the risk of further spread. This paper describes the examination of cattle slurry for the presence of *Brucella abortus* and the treatment of cattle slurry on a number of farms with *Brucella* infected herds.

## The Presence, Survival and Inactivation of *Brucella abortus* in Manure

Plommet and Plommet (1974) reported the presence of *Brucella abortus* in cattle slurry, and Haahsy and Heneghan (1999) recorded the isolation of *Brucella* organisms in slurry collected at seven of twelve farms with brucellosis affected herds in Ireland in 1999. The recorded survival of *Brucella abortus* in slurry ranges from 7 days (Rankin and Taylor, 1969) to 240 days (Verger, 1981). The distances recorded for the dispersal of bacteria when land-spreading slurry include 274 metres (Evenden, 1972), 400 metres (Tamasi, 1983), 350 metres (Boutin *et al.*, 1988) and 800 metres (Haahsy *et al.*, 1996).

The principal measures which can be applied at farm level to minimise the risk of dispersing pathogens when land-spreading animal effluents are: a) long term storage of slurry to allow pathogens to die off before land application and b) treatment with chemicals.

A storage period of at least eight months and preferably longer after cattle leave a shed is advisable when brucellosis occurs in a herd. Long term storage is not normally a problem in the case of solid manure. However, the capacity of slurry tanks on many farms is not adequate to permit prolonged storage of liquid slurry. Treatment with chemicals prior to land-spreading is an alternative. For instance in Germany, when brucellosis occurs in cattle, slurry must be treated with either a) formalin or b) 'thick lime milk', i.e. a mixture of calcium hydroxide powder and water.

## Field Investigations

### a) Isolation of *Brucella abortus* in cattle slurry.

Samples of liquid cattle slurry were collected from a total of 22 brucellosis affected herds. The slurry samples were cultured and examined for the presence of *Brucella* spp. at The Brucellosis Laboratory, Department of Agriculture, Food and Rural Development, Cork. *Brucella abortus* was isolated from six of the twenty two slurry samples examined.

### b) Chemical treatment of slurry on five farms.

The practicality of treating slurry with chemicals at farm level and developing a set of guidelines for future use was then examined. Cattle slurry at five farms with brucellosis-affected herds was treated

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with either a) calcium hydroxide powder or b) 'thick lime milk'. Calcium hydroxide powder is also referred to as 'hydrated lime', or 'slaked lime' or 'builder's lime' is readily available from building supply merchants. The calcium hydroxide powder was packed in 25 kg bags, while the 'thick lime milk' was mixed at the lime manufacturing plant and delivered by lorry tanker. Slurry was stored in underground tanks on three farms while on the other two it was contained in open outdoor tanks.

In Germany 'thick lime milk' (TLM) is one of the products approved for use in the treatment of slurry on farms where brucellosis occurs. The stipulated rate is 60 kg per m<sup>3</sup> using a 40% concentration of TLM. Slurry was treated with 'thick lime milk' on two farms in this study. An equivalent rate of calcium hydroxide powder was used on a further three farms to assess its suitability in areas where liquid 'thick lime milk' might be difficult to obtain.

The quantity of chemical added and the procedure used were similar to those employed in Germany. The purpose of the treatment was to increase the normal pH level in cattle slurry (normally 7.0 approximately) to a level above pH 12.0 and to maintain it at this pH for at least four days.

The effectiveness of the treatment on the five farms was measured by the increase in the slurry pH over a four-day period following the addition of the chemical.

The procedure used was as follows:

1. Treatment of slurry was timed to take place up to four weeks before it was due to be spread on farmland. When slurry is left in storage for a longer period after treatment, the lime may settle on the floor of the tank and can lead to problems when the slurry is being removed.
2. Slurry was well agitated to ensure that it was fluid before the addition of the liming materials. Lumps of solid matter were broken and mixed with the liquid. In one case it was necessary to remove some slurry from the tank as the slurry was in contact with the slats and this impeded movement and effective agitation. On a second farm, the slurry had a relatively high dry matter content and it was necessary to add water to get effective agitation.
3. Either 'TLM' or calcium hydroxide powder was added to the tanks at the slurry agitation points which were located outdoors. Agitation took place as the lime was being added and was continued for six hours afterwards on the first day. The slurry was agitated for up to three hours per day on the second, third and fourth days.
4. The volume of slurry to be treated in each tank ranged from 218,996 to 581,180 litres, while the quantity of calcium hydroxide was varied from 4.6 to 11.75 tonnes. A Hanna portable pH meter was used to measure pH levels in samples of slurry which were collected at various points in the slurry tanks before and after treatment.

## Results

The pH levels of the slurries before treatment ranged from 5.7 to 7.5. The addition of 'TLM' or calcium hydroxide powder both resulted in an increase to pH levels of greater than 12.0 on all farms. The pH readings remained above 12.0 over a four-day period in each case. These figures are presented

in Table 1, along with details of the volume of slurry treated and quantity of calcium hydroxide used at each farm.

**Table 1.** Volume of slurry, quantity of lime added and pH levels recorded in slurry tanks at five farms.

Farm	Volume of slurry - litres (gals)	Quantity calcium hydroxide (tonnes)	Initial pH	pH after treatment	
				Day 1	Day 4
1	361,013 (57,762)	5.30	7.0	12.4	12.5
2	581,180 (128,013)	11.75	6.9	12.9	12.9
3	218,996 (48,237)	4.90	7.2	12.8	12.8
4	227,000 (50,000)	4.6 t in 8000 l water	5.7*	12.8	12.7
5	a) 357,525 (78,750)	7.3 t in 12,000 l water	7.4	12.7	12.8
	b) 357,525 (78,750)	7.3 t in 12,000 l water	7.4	12.8	12.8
	c) 357,525 (78,750)	7.3 t in 12,000 l water	7.5	12.7	12.7
	d) 190,680 (42,000)	3.8 t in 6,500 l water	7.4	12.7	12.8

\*contained silage effluent

## Discussion

The treatment used to raise the pH of slurry to a level above 12.0 and maintain it at that level for four days was effective on each of the five farms in this study. This demonstrated that the addition of 'thick lime milk' (TLM) or calcium hydroxide powder to slurry can be an effective and practical form of treatment at farm level. However, it is necessary that a number of points are followed. These include efficient agitation of slurry before the addition of lime, thorough mixing of slurry with lime and the removal of the slurry within weeks after treatment in order to avoid possible difficulty with lime settling in the storage tank. Where difficulty is encountered in agitating slurry effectively, it may be the result of either an inadequate clearance between the slurry and the slatted floor in cattle sheds, a high dry matter content in slurry or by inadequate agitation power. See Appendix.

While both the liquid 'TLM' and calcium hydroxide powder forms of lime were effective, the liquid preparation was more convenient to use due to the elimination of a) the manual handling of bags and b) the dust associated with calcium hydroxide powder. However, the cost of liquid lime is higher than the powder form due to the extra transport costs.

The quantity of chemical required to treat slurry on a farm will vary with herd size. Based on a volume of 6,800 litres of slurry per cow and the mean number of 60 cows in herds depopulated due to brucellosis in Ireland recently, a quantity of 8,250 kg calcium hydroxide powder is required. In order to form 'thick lime milk', this quantity of lime powder is mixed with 20,000 litres water and forms approximately 24,000 litres 'thick lime milk'. The cost of this quantity of lime milk is approximately £1,400. The extra agitation that is required to mix lime with slurry lime is likely to cost £350 for a herd of this size.

Strauch (1981) reported that a number of chemicals, including calcium hydroxide powder and 'thick lime milk', were suitable for disinfecting slurry and were tolerated by crops on which treated slurry was applied at rates of up to 20 m<sup>3</sup>/ha. However, Haheisy *et al.* (1996) found that there can be a reduction in grass dry matter yield, ranging from 11% to 17%, following the application of lime treated

slurry at a rate of 35 m<sup>3</sup>/ha. This reduction may be caused by the release of ammonia from slurry when lime is mixed with it, resulting in a reduced nitrogen content. The quantity of lime contained in treated slurry is equivalent to 27 kg ground limestone (CaCO<sub>3</sub>) per 1000 l slurry, and is in a form more readily available to the soil than ground limestone.

The method described here for treating liquid cattle slurry with lime is not suitable for use with farmyard manure, i.e. dung and straw bedding, or with dungstead manure, i.e. dung from which part of the liquid content has drained. Composting of these two types of manure for a period adequate to kill off pathogens is acceptable, provided the stores are fenced to prevent access to cattle and are located so as to avoid causing water pollution.

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## Appendix

Guidelines for the treatment of cattle slurry with lime, in order to increase the pH level.

- ◆ The following set of guidelines for treating slurry by the addition of a) 'thick lime milk' liquid or b) calcium hydroxide powder is based on a) the application of the regulations which apply in Germany and b) experience with the treatment of slurry with lime at five farms in Ireland in 2000.
- ◆ Precautions are necessary to avoid harm to the health of people involved in the agitation of slurry and the addition of lime. Hydrogen sulphide gas (slurry gas) is released during the agitation of slurry, especially in the early stages and can be fatal. In addition, ammonia may be emitted from slurry after the addition of lime and can cause eye irritation and breathing difficulties for those in the vicinity.
- ◆ The addition of calcium hydroxide powder can be an effective way of increasing pH levels, but the use of this product can involve more difficulties than 'thick lime milk' liquid. These include the manual lifting of bags and working in very dusty conditions.
- ◆ It is advisable to arrange the treatment of slurry so that it is carried out shortly before the slurry is to be spread on farmland, preferably within one month. This is recommended so that lime will not settle in the base of the tank and create removal difficulties. If it is not possible to spread slurry for a time after treatment e.g. due to adverse weather conditions, it is advisable to agitate it for a period each week to keep the lime in suspension in the slurry.
- ◆ Agitation must take place before lime is added so that all the slurry in the tank is fluid and free from solid lumps. A period of two to four hours agitation is generally required to achieve this, depending on the dry matter content and the presence of solid material e.g. silage.
- ◆ On farms where slurry tanks are full, it will be necessary to reduce the level of slurry in advance, to ensure that the slurry does not reach the slats during agitation. Failure to do this can impede the movement of slurry and make it difficult to break lumps of solid material. When adding thick lime milk an additional reduction of 10 to 15 cm in surface level will be required.

- ◆ Where slurry has a high dry matter content (>10%) due to e.g. the removal of liquid during the winter or the feeding of relatively dry roughage including baled silage, it will be necessary to add some water to assist agitation.
- ◆ In relatively short slurry tanks e.g. 15 m (three bays), all the lime can be added at one end. Where slurry is stored in longer tanks, it is advisable to add lime at each end, to ensure even distribution of lime in the slurry.
- ◆ Checking the pH levels at numerous points can be used to assess the effectiveness of agitation in mixing slurry and lime in all parts of a slurry tank. When a uniform pH reading above pH 12.0 is recorded at each point sampled this indicates that the lime has been mixed with slurry throughout the tank.
- ◆ When large tanks of slurry are being treated, it may be necessary to use two agitators in order to get good movement and agitation in slurry.
- ◆ Dungstead manure has a relatively high dry matter level due to the loss of part of the liquid content. In general it is not possible to agitate dungstead manure, so treatment with lime is not an effective method of inactivating pathogens. Long term storage is an alternative way. Similar treatment is recommended for solid farmyard manure.
- ◆ The relevant details are contained in the Guidelines of the German Federal Ministry for Food, Agriculture and Forestry on the means and methods of carrying out disinfection in notifiable animal epidemics. These include: