

Manure management and hygienic conditions of dairy cows in cubicles bedded with separated manure solids

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Abstract

Manure management affects hygiene, animal welfare, work organization and costs on dairy farms. The use of recycled separated manure solids as bedding for loose housed dairy cows is considered cost-effective because avoiding the purchase of bedding material.

The main aim of the research was to improve housing systems and manure management in dairy farms in order to favour better conditions of welfare and hygiene of cows and to reduce costs of dairy farms.

Housing system, equipment, machines, labour and litter usage were considered as well as skin dirtiness, locomotion scores and quality of milk of loose housed dairy cows were assessed and compared among reference dairy farms using and not using separated solids as bedding.

Comparison of dirtiness and locomotion scores showed significant differences among the surveyed dairy farms using different housing systems and different type and amount of bedding in lying area. Lowest dirtiness and locomotion scores were found in barns with cubicles using more than 2 kg/cow.d of straw while the highest scores were found in cubicles using no litter and in barns with sloped bedded floor.

The survey showed acceptable hygienic conditions of dairy cows housed in cubicle barns using separated manure solids even if the assessment of milk quality pointed out relatively high content of somatic cells even if not directly correlated to the use of such bedding. Anyway as bedding may play a role in the cleanliness of the udder, a careful pre milking hygiene routine may be advisable to control mastitis when using separated manure solids.

Keywords: dairy cows, manure management, hygiene, bedding.

Introduction

Manure management affects hygiene, animal welfare, work organization and costs on dairy farms (Barbari and Ferrari 2006; Barbari *et al.* 2007). The use of recycled separated manure solids as bedding for loose housed dairy cows is considered cost-effective because avoiding the purchase of bedding material. Actually this practice is applied by several dairy farms in USA and by a few modern dairy farms in Italy. However there are some resistances from farm advisors and veterinarians because the high bacterial populations in bedding material would influence the level of bacterial counts on udder surface, particularly on teat ends, and would increase the risk of mastitis.

Researches carried out in USA to assess the hygienic feasibility of this practice found that properly composted and dried manure solids, with more than 60% dry matter and no or few coliforms, may be used as free stall bedding in conjunction with stringent mastitis control measures without increasing incidence of coliform mastitis (Allen *et al.*, 1980). Composting manure solids effectively reduces coliform counts to few or to zero but coliform counts can

increase if the compost in the barn becomes moist or is contaminated by external factors, such as faeces or urine (Carroll and Jasper, 1978). Therefore dried composting manure was found satisfactory material for bedding of free stalls if it was dried properly before application.

Zehner *et al.* (1986) compared various bedding materials and demonstrated that clean, damp bedding may support bacterial growth; they also suggested that high bacterial counts under barn conditions are influenced by factors more complex than type of bedding used. High moisture levels of organic bedding materials result in rapid growth of environmental bacteria in the bedding contributing to high populations of bacteria on teat ends. Thus the reduction of humidity in manure material is the main consideration of separating dairy manure. However, when bedding materials become mixed with manure and urine, rapid growth of environmental mastitis pathogens starts because of available nutrients (Novák *et al.* 2004).

Schrade *et al.* (2006) found that bedding material of compost and recycled manure solids is comparable with straw mattresses from the point of view of cubicle maintenance, animal welfare and hygiene.

With regard to the effectiveness of chemical treatments of separated manure solids Hogan *et al.* (1999) compared bacterial counts of untreated recycled manure bedding and those of recycled manure bedding treated with either an alkaline commercial bedding conditioner, acidic commercial bedding conditioner or hydrated lime. The results of this study showed that the use of acidic conditioner in recycled manure has little effect on bacteria in bedding and that alkaline conditioners initially reduce bacterial counts even if the antibacterial effects diminish two days after the treatment. However this kind of treatments may be suggested for herds affected by high rate of mastitis in order to control the fast bacterial growth during the first 2-3 days after bedding.

The main aim of this study is to improve loose housing systems and waste management in dairy farms in order to improve welfare and hygiene of cows and to reduce costs for dairy farms.

Materials and methods

Twelve dairy farms were considered in this study in order to compare hygienic conditions of milking cows in loose housing systems with different lying areas and manure management. The study was focused principally to assess how the practice of using manure solids as bedding influences hygienic conditions and health of milking cows.

Three dairy farms using recycled separated manure solids as bedding in cubicles have been surveyed. In these farms fresh manure solids are spread in cubicles every two weeks just next to mechanical separation without any previous chemical or physical treatments. The dry matter content of manure solids in the cubicles was analyzed two times per farm in summer and winter.

The other farms, except for farm 7, were used to spread organic bedding materials (chopped or whole straw or wood shavings) in cubicles or in sloped floor areas two or three times a week. The nine farms not using manure solids as bedding (from 4 to 12 in table 1) were selected among a sample of forty dairy farms already investigated within a survey on manure management in dairy farms in order to be representative for the most popular and the most modern loose housing systems for dairy cattle in Emilia-Romagna.

In every cowshed skin dirtiness score (DS) and locomotion score (LS) of milking cows were tested and bulk milk somatic cell count (SCC) was recorded.

SCC is one of the indicators of udder health and milk quality.

The DS method was used to analyze five anatomical parts of cows' body: sacro-ischiatic part viewed from the back; back side of the udder viewed from the back; front side of the udder viewed from both sides; legs; feet. The score for each anatomical part varies from 0 to 2 within the following steps: 0 = clean; 0.5 = a few small dirty areas; 1 = less than 50% covered with dirt; 1.5 = more than 50% covered with dirt; 2 = totally covered with dirt. Therefore the total score for each cow ranges from 0 to 10. The number of total scores to be collected in each farm are more than 50% of the number of milking cows in the herd; choice of cows to be scored is random. The mean value of the dirtiness total scores of cows tested in each cowshed expresses the cows' dirtiness score of that cowshed (Houdoy, 1992).

LS is a qualitative index of cows' ability to walk normally (Berry, 1997); it is visually scored on a scale of 1 to 5, where a score 1 reflects a cow that walks normally and a score of 5 reflects a cow that is three-legged lame. LS can also be used to determine the expected milk revenue losses due to lameness.

In each cowshed type of lying area, type of bedding, bedding consumption, manure removal system and type of flooring were considered (Table 1). The following kinds of lying areas were analyzed:

- cubicles bedded with manure solids;
- cubicles bedded with 2 kg . cow⁻¹ . d⁻¹ or more of straw;
- cubicles bedded with less than 1 kg . cow⁻¹ . d⁻¹ of straw or wood shavings;
- cubicles not bedded;
- sloped bedded floor.

Cubicles of farms 5 and 7 are provided with mattresses in order to improve cows' comfort and to avoid or minimize the use of bedding. Farms 1, 3, 4 and 5 are equipped with pumps for flushing; except for farm 5 they are provided with mechanical separator for processing manure in order to separate solids from the liquid manure used for flushing. Cowsheds of farms 8, 9, 10, 11 and 12 are equipped with automatic scraper conveyers.

Table 1. Technical parameters of lying areas, bedding use, type of flooring in passages and manure handling systems in twelve reference cowsheds

Farm	Lying area	Type of bedding	Bedding use kg cow ⁻¹ d ⁻¹	Type of flooring	Manure removal system
1	Cubicles	Manure solids	9.0	Solid	Flushing
2	Cubicles	Manure solids	9.0	Solid	Scrapers
3	Cubicles	Manure solids	9.0	Solid	Flushing
4	Cubicles	Chopped straw	2.0	Solid	Flushing
5	Cubicles - mattresses	Wood shavings	0.7	Slatted	Flushing
6	Cubicles	Wood shavings	0.4	Slatted	Storage pit
7	Cubicles - mattresses	-	0.0	Slatted	Storage pit
8	Cubicles	Straw	3.3	Solid	Scrapers
9	Cubicles	Straw	0.9	Solid	Scrapers
10	Cubicles	Straw	2.3	Solid	Scrapers
11	Sloped bedded floor	Straw	3.0	Solid	Scraper
12	Sloped bedded floor	Chopped straw	2.4	Solid	Scraper



Figure 1. Manure solids and press screw separator



Figure 2. Cubicles bedded with of straw (a); cubicles provided with mattresses and bedded with wood shavings (b); cubicles bedded with manure solids (c)

Results and discussion

Dirtiness scores were collected from 1284 milking cows and lameness score on 1183 heads; the number of cows tested per farm varies from 30 to 431.

SCC analyses of bulk milk were collected for every farm from August 2004 till July 2007, except for farms 1 and 2 (from January 2005 till July 2007), for farm 3 (from June 2006 till July 2007) and for farm 4 (from September 2006 till July 2007).

In cowsheds 1, 2 and 3 the dry matter content of manure solids used in free stalls was 42.1% on average.

Table 2 shows different values of DS, LS and SCC of milking cows in the surveyed cowsheds with different housing systems and with different type and amount of bedding.

Significant differences were found among mean values of DS, LS and SCC (ANOVA one-way) of the three cowsheds where manure solids are used and the other categories of cowsheds (tables 3 and 4).

The average DS of surveyed cowsheds in which manure solids are used was found relatively higher (3.38) than cowsheds provided with bedded cubicles (1.68 and 2.72) but lower than cowsheds provided with not bedded cubicles (4.81) or sloped bedded floor (5.12) in the lying area. The results of this study suggests that the practice of using fresh not treated separated manure solids would not improve cleanliness of cows in comparison with the use of

traditional bedding materials like straw and wood shaving. Anyway the relatively high value of DS for cows bedded with manure solids could be affected by the relatively high water content of this bedding material which was used in the surveyed farms next after mechanical separation without any previous chemical or physical treatments.

LS of farms using manure solids was found higher (1.35) than LS of farms with cubicles bedded with 2 kg cow⁻¹d⁻¹ or more of straw (1.16) but lower than farms with cubicles non bedded (4.81) while it was not found significantly different from cowsheds provided with cubicles and less than 1 kg cow⁻¹ d⁻¹. Although LS of cows is affected by various factors such as the type of flooring, feeding programs and hooves health and care, these results did not show any negative effects of using manure solids as bedding on the health of cows' hooves.

Table 2. Dirtiness scores, locomotion scores and bulk milk SCC in the surveyed reference cowsheds

Shed	Lying area	Bedding use kg cow ⁻¹ d ⁻¹	DS	LS	SCC ¹
			Mean±SD	Mean±SD	Mean±SD
1	Cubicles	9.0	3.46±1.08	1.36±0.76	328±65
2	Cubicles	9.0	3.59±0.74	1.30±0.54	319±68
3	Cubicles	9.0	2.70±0.93	1.36±0.75	327±112
4	Cubicles	2.0	1.83±0.51	1.17±0.48	333±133
5	Cubicles - mattresses	0.7	2.46±0.53	1.41 ±0.79	248±85
6	Cubicles	0.4	4.77±0.76	1.45±0.74	143±89
7	Cubicles - mattresses	0.0	4.81±0.76	1.68±0.80	515±177
8	Cubicles	3.3	1.41±0.33	1.15±0.41	147±44
9	Cubicles	0.9	2.14±0.68	1.25±0.55	136±29
10	Cubicles	2.3	1.88±0.52	1.16±0.44	190±76
11	Sloped bedded floor	3.0	5.32±0.88	1.18±0.45	489±125
12	Sloped bedded floor	2.4	4.77±0.98	1.41±0.83	359±189

¹⁾ Nr. · ml⁻¹ · 1000

Table 3. Dirtiness scores, locomotion scores and bulk milk SCC in cowsheds with cubicles in lying area

Nr. sheds	Lying area	DS	LS	SCC ¹
		Mean±SD	Mean±SD	Mean±SD
3	Cubicles bedded with manure solids	3.38 ^B ± 1.01	1.35 ^B ± 0.72	323 ^B ± 72
3	Cubicles bedded with more than 2 kg cow ⁻¹ d ⁻¹	1.68 ^D ± 0.50	1.16 ^C ± 0.44	231 ^C ± 126
3	Cubicles bedded with less than 1 kg cow ⁻¹ d ⁻¹	2.72 ^C ± 1.12	1.35 ^B ± 0.69	185 ^D ± 92
1	Cubicles not bedded	4.81 ^A ± 0.77	1.68 ^A ± 0.80	514 ^A ± 177

¹⁾ Nr. · ml⁻¹ · 1000

A, B, C, D) P < 0.01

Table 4. Dirtiness scores, locomotion scores and bulk milk SCC in cowsheds with cubicles bedded with manure solids and in cowsheds with sloped bedded floor

Nr. sheds	Lying area	DS	LS	SCC ¹
		Mean±SD	Mean±SD	Mean±SD
3	Cubicles bedded with manure solids	3.38 ^B ± 1.01	1.35 ± 0.72	323 ^B ± 72
2	Sloped bedded floor	5.12 ^A ± 0.95	1.26 ± 0.62	428 ^A ± 170

¹⁾ Nr. · ml⁻¹ · 1000

A, B) P < 0.01

Bulk milk SCC of cowsheds in which manure solids are used (323000) was found higher on average than cowsheds with bedded cubicles (231000 and 185000) even if lower than cowsheds with not bedded cubicles (514000) and cowsheds with sloped bedded floor (428000). These data showed acceptable health conditions of udders for surveyed cows housed in free stalls bedded with manure solids even if worse than those of cows housed in free stalls bedded with straw or wood shavings. Nevertheless SCC may be affected by other factors which play an important role in the health of udders such as the feeding program, the climate, the milking routine and the maintenance and settings of the milking machine.

Conclusions

The survey showed acceptable hygienic conditions of dairy cows housed in cubicle barns using separated manure solids even if the assessment of milk quality pointed out relatively high content of somatic cells but not directly correlated to the use of such bedding. However, as bedding may play a role in the cleanliness of the udder, a careful pre milking hygiene routine may be advisable to control mastitis when using separated manure solids.

Generally the research highlights the importance of housing systems to keep milking cows in acceptable hygienic conditions. Best hygienic conditions have been assessed in cubicle cowsheds using plenty of straw. Sloped bedded floor in lying area would not be advisable because of the high levels of cows' skin dirtiness and SCC even if LS management cost of cowsheds with sloped bedded floor was found relatively low.

The main advantage of recycling manure solids for bedding is the low material cost which is zero if free available on farm; in this case the estimation of cost savings is 43.6 € cow⁻¹year⁻¹ with reference to labour, machine and material costs in Emilia Romagna Region. The drawback of this practice is the high capital to invest for mechanical separator. For these reasons the purchase of a liquid manure separator for producing manure solids as bedding is only worthwhile for relatively large farms or for collective use.

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