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Mechanical cleaning of slatted floors

The cleaning effect of a cleaning device for slatted floors was tested under practical conditions in a dairy barn and with a test stand. Next to a scraper for slatted floors, star rotors to unblock the gaps in the floor and a high pressure cleaner were investigated. In order to assess the individual cleaning steps, a test stand was build to evaluate the single cleaning steps. The maximum cleaning efficiency is reached during the time when cows are on the pasture and the slatted floor is given a chance to dry. A high pressure cleaning qualifies when faeces did not dry yet and could be washed off the slatted floor.

Keywords
Cleaning of slatted floors, cleaning effect, test stand, dairy barn

Abstract
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In modern dairy farming, most of the cows are housed in loose housing systems [1]. Practical experience shows that slatted floors tend to have a non-sufficient self cleaning effect. This leads to clogging of the gaps in the floor and a diminished runoff of faeces and urine from the walking area. Wet and soiled walking areas affect the hygiene and health of claws [2]. Furthermore, soiled walking areas generate a great amount of ammonia emission [3].

In order to improve barn-hygiene and to reduce emission potentials, various cleaning systems are in use. In addition to simple scrapers, cleaning methods including water are used to flush the walking areas [3].

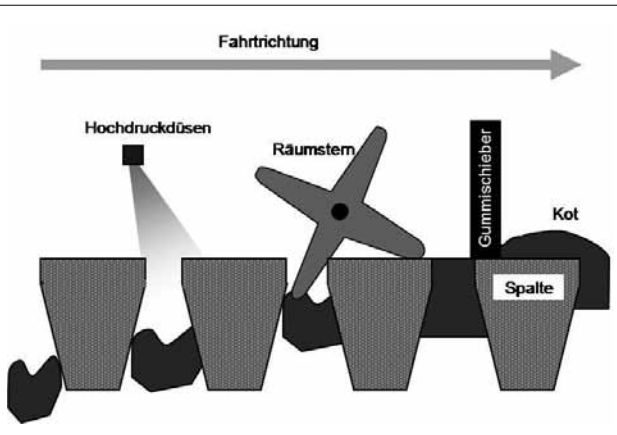
The remaining amount of manure on slatted floors after performing different methods of cleaning was compared to non-cleaned floors in order to evaluate the individual mechanical cleaning efficiency.

Material and methods

In order to clean concrete slatted floors in dairy barns efficiently, a spacial cleaning devise was developed (Westermann GmbH und Co KG, Meppen). The so called „Cleanmeleon 3“ combines a mechanical removal of faeces and urine from slatted floors with a rubber scraper and star rotors made of polyurethane with a high-pressure water cleaning (**Figure 1**). The rubber scraper and the star rotors push faeces through the gaps in the slatted floor and water nozzles remove the smeared layer of manure from the walking area.

This cleaning device was investigated in a barn housing 90 dairy cows (Holstein-Friesian) on straw bedding and slatted floors. The cleaning of the slatted floors was carried out in the morning at 8:00 am, after the milking had been finished. In order to investigate the cleaning effect inside the barn, exchange-

Fig. 1



Cleaning device „Cleanmeleon 3“ and plan of the cleaning steps

Fig. 2

Test stand with rubber scraper, extractable star rotors, high pressure cleaner and dripping frame for artificial soiling

able elements of the slatted floor (62 x 50 x 20 cm) had to be cut out and separated from the existing walking area. The slat elements were weighed with a digital crane scale (KHW003, Firma Bosche, Damme) and the amount of manure clinging to the slat element was determined gravimetrically. The net weight of each individual slat element had been determined before the test phase and was subtracted from the measured weight. This way the amount of manure on the slatted floor could be calculated. A part of the walking area inside the barn was used as a control area and did not get cleaned during this study in order to be able to compare the effect of the cleaning device with a non-treated slatted floor.

The measurements were carried out during two different housing conditions. First during the housing period, when the cows spent the whole day inside the barn, and second during the pasture period, when the cows were kept on pastures close to the barn during the day. Additionally, the mechanical cleaning effect was determined at different points of time after the cleaning.

The walking area inside the barn is divided into two parts, the section next to the feeding aisle and the section between the cubicles. These different sections are observed separately from each other to take possible effects of varying animal activity into consideration.

To be able to investigate the cleaning effect of the individual components of the cleaning device, a test stand was developed which simulates the different cleaning steps (**Figure 2**).

The different cleaning versions tested with the test stand are listed in **Table 1**.

During the measurements with the test stand two different soiling versions were applied. On the one hand side there was an artificial soiling during which the slat element were submerged in a tank filled with manure to ensure a homogeneous coverage of the slats with manure (mean amount of manure on the slats: 3,0 ± 0,3 kg). On the other hand naturally soiled slats were removed from the barn to cover possible clogging of the gaps, even though the soiling degree of the individual slats is not uniform. The different cleaning versions were always compared with a non-treated control version.

Table 1

Cleaning versions with the test stand

Variante *Version*	**Reinigung** *Cleaning*
G	Gummischieber/*rubber scraper*
GR	Gummischieber + Räumsterne/*rubber scraper + star rotors*
GRH	Gummischieber + Räumsterne + Hochdruckreinigung *rubber scraper + star rotors + high pressure cleaning*
K	„Kontrollspalte“ = keine Reinigung/*control slat = no cleaning*

Table 2

Comparison of the cleaning effect on the control slats and the cleaned slats during different types of housing at different times after the cleaning

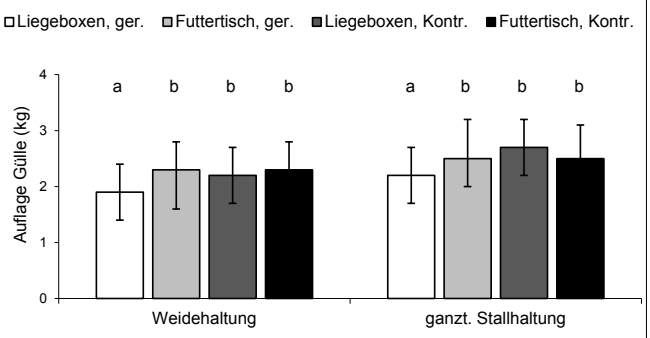
Haltungsform *Housing system*	**Zeitpunkt der Messung nach der Reinigung** *Time of measurement after the cleaning*	**Kotauflage (kg)** *Amount of manure (kg)*		**Mechanische Reduktion der Kotauflage (%)** *Mechanical reduction of manure (%)*
		Kontroll spalten *Control slats*	**gereinigte Spalten** *Cleaned slats*	
Weidehaltung *Pasture grazing*	0 h	2,5 ± 0,5	1,7 ± 0,4	35,3
	4 h	2,6 ± 0,6	1,2 ± 0,4	54,9
	6 h	2,0 ± 0,3	1,7 ± 0,4	15,2
Ganztägige Stallhaltung *Indoor system*	0 h	2,7 ± 0,5	1,8 ± 0,4	32,7
	4 h	2,6 ± 0,5	1,8 ± 0,6	28,8
	6 h	2,6 ± 0,6	2,5 ± 0,5	5,5

Results and discussion

Table 2 shows the mechanical cleaning effect on the slat elements compared with non-cleaned control slats during both housing systems and at different points of time after the cleaning.

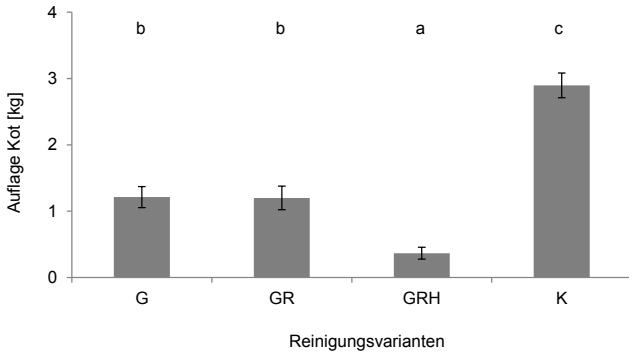
The reduction of the amount of manure on the slats straight after the cleaning during both housing systems is 35,3 % (pasture period) and. 32,7 % (housing period), respectively. Six hours after the cleaning there is still an effect of 15,2 % during the pasture period. This possibly accounts to a drying of the control slats. If the cows are outside the barn during the day, also control slats can partly dry and therefore lose weight with a reduced matter of urine and faeces. During the housing period a cleaning effect of only 5,5 % can be found six hours after the cleaning. Because of the daily presence of the cows inside

Fig. 3



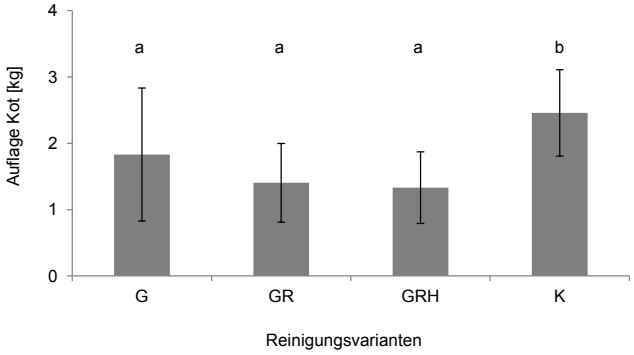
Amount of faeces on the slats in the barn. Different letters indicate significant differences of mean values (p ≤ 0,05)

Fig. 4



Amount of manure on the artificially soiled slats. Different letters indicate significant differences of mean values (p ≤ 0,05)

Fig. 5



Amount of manure of naturally soiled slats. Different letters indicate significant differences of mean values (p ≤ 0,05)

the barn a continuous soiling of the slatted floor takes place and there is nearly no cleaning effect to be determined anymore six hours after the cleaning.

The reproducibility of the data is very low because of the varying content of water on the slats, due to differing dry matter contents of the manure as well as the input of water during the cleaning process.

Figure 3 shows the amount of manure on the cleaned slats compared to the control slats just before the cleaning was conducted. This means, the last cleaning procedure took place 24 hours ago. The two different sections in the barn show that a sustainable reduction of the amount of manure on the slats can be achieved in the cleaned area between the cubicles (1,9 ± 0,5 kg, pasture period; 2,2 ± 0,5 kg, housing period) compared to the control area between the cubicles (2,2 ± 0,5 kg, pasture period; 2,7 ± 0,5 kg, housing period). This effect cannot be found in the section next to the feeding aisle. It is likely that an input of forage on the walking area leads to a more rapid clogging of the gaps and therefore an enhanced accumulation of manure on the slatted floor [4].

The results of the test stand show a statistical significant cleaning effect on the reduction of the amount of manure on the slats. During the artificial soiling (**Figure 4**) the wet cleaning version (GRH) shows a clear advantage (0,4 ± 0,1 kg) over the dry cleaning versions featuring only the rubber scraper (G) and the additional star rotors (GR). The control version has a mean amount of manure of 2,9 ± 0,2 kg.

The cleaning version featuring rubber scraper and star rotors (GR, 1,2 ± 0,2 kg) does not show an advantage compared to the version using only the scraper (G, 1,2 ± 0,2 kg) in terms of manure removal from the slats, even though both versions show a statistical significant difference compared to the control version (K). This shows that using artificial soiling with thin fluid manure does not lead to a clogging of the gaps in the slatted floor; hence no faeces have to be pushed through the gaps in order to improve the cleaning effect.

Observing the naturally soiled slat elements, a significant difference between the mean amounts of manure on the cleaned versions and the control version (2,6 ± 0,7 kg) can be found. However, there is no significant difference between the cleaned versions. Yet, the cleaning version with the star rotors (GR) with a mean amount of manure of 1,4 ± 0,6 kg tends to perform better than the cleaning version with only the rubber scraper (G) showing mean amounts of manure of 1,8 ± 1,0 kg. On the contrary, the cleaning version using water (GRH, 1,3 ± 0,5 kg) shows no improvement of manure removal compared to the dry cleaning version GR. This indicates a mechanical cleaning effect of the star rotors when using naturally soiled slat elements with partly dried on and sticking faeces. High pressure cleaning with water only adds to a cleaning effect when the manure clinging to the concrete is fresh and easy to be rinsed off.

Conclusion

During the time of pasturing the slatted floor inside the barn has a chance to dry after being cleaned, leading to a mechanical cleaning effect of 54,9 % four hours after cleaning. However, the inhomogeneity of the soiling of the slats during practical studies and the resulting high deviation of the measured data do not allow drawing precise conclusions concerning the clean-

ing effect of a cleaning devise for slatted floors. With regard to further studies it is recommended to calculate the dry matter content of the manure on the slat elements, in order to exclude the influence of variable water content.

A slightly sustainable cleaning effect on the reduction of manure on the slatted floor can only be observed in the area between the cubicles. In the area next to the feeding aisle additionally introduced forage supports a rapid re-soiling of the slatted floor.

Using artificially soiled slat elements, a clear advantage of the cleaning version featuring the high pressure water nozzles over to the dry cleaning versions with only the scraper and the star rotors can be observed. During natural soiling the star rotors can provide a small improvement in the removal of manure compared to the rubber scraper, if clogged gaps are the case.

Hence, the superficial cleaning of the slat elements proves to be satisfying; however, no depth effect can be achieved during the cleaning process. Using naturally soiled salt elements at least 50 % of the manure remains on the slats.

The cleaning version using water is effective, only if the manure has not dried and can be rinsed off easily which makes high cleaning intervals necessary. Out of economical reasons, high cleaning intervals cannot be provided with a cleaning device that has to be conducted by hand. Alternatively, an automatically run cleaning system could provide a practical solution.

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