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Use of Biochar-peat Mixture to Reduce Odour from Animal Farms

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Abstract. Odour from agriculture causes local nuisance to the neighborhood. Litter and cover materials can be used in animal housing and in storage of manure to reduce the odour problem. The use of biochar as a covering for animal manures is a new innovation and enhances the possibility to minimize the emissions from animal farms. (*Research purpose*) To study the possibility of using a mixture of biochar and peat as a manure covering, in order to reduce the intensity of odor on livestock farms. (*Materials and methods*) The potential of a mixture of biochar and peat for the odour control was tested in a laboratory study. A 10 cm layer of fresh mink manure was placed on the bottom of a 5 liter test bucket and the manure was covered with biochar-peat mixture (mixed in 50/50 ratio by volume) using five different covering thicknesses. Uncovered manure was used as a reference. The odour emission was measured with an olfactometric method that is based on odour sensation of a person. Also the character of the odour was described. (*Results and discussion*) The results show that a biochar-peat covering of at least 3 cm is able to considerably reduce the odour from the manure. The character of the odour was at first peat-like for all covered buckets but with thin coverings it was changed to more manure-like after 2 days. The odour from buckets with thicker covers remained peat-like during the whole testing period. (*Conclusion*) It is recommended to apply a biochar-peat covering to neutralize ammonia and the unpleasant manure odour on livestock farms. The author has shown that the frequency of use and the thickness of a covering layer depend on the ambient temperature; therefore, it is not necessary to cover manure in winter.
Keywords: emission, neutralization of unplesant odour, annoyance, biochar, peat, animal husbandry.

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Использование смеси биоугля и торфа для снижения интенсивности запаха от животноводческих ферм

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Реферат. Неприятный запах от сельскохозяйственных животноводческих предприятий доставляет определенные неудобства расположенным поблизости жилым и производственным объектам. Чтобы уменьшить проблему с запахом, в животноводческих помещениях и при хранении навоза могут быть использованы для укрытия различные материалы, включая подстилочные. (*Цель исследования*) Изучить возможность использования смеси биоугля и торфа в качестве присыпки для навоза, чтобы снизить интенсивность запаха на звероводческих фермах. (*Материалы и методы*) В лабораторных условиях исследовали свойства смеси биоугля и торфа для нейтрализации запаха. Свежий навоз от норок слоем 10 сантиметров поместили на дно 5-литрового тестового резервуара. Покрыли его смесью биоугля и торфа (в соотношении 50/50 по объему). Использовали 5 вариантов толщины покрытия. Непокрытый смесью навоз приняли за контрольный образец. Интенсивность запаха определяли обонятельным методом. Описали характер запаха. (*Результаты и обсуждение*) Выявили, что покрытие навоза смесью биоугля и торфа толщиной не менее 3 сантиметров способно значительно уменьшить запах. Характер запаха был сначала торфоподобным во всех покрытых смесью резервуарах, но при тонком покрытии через 2 дня он становился более похожим на запах навоза. Запах от резервуаров с покрытием большей толщины оставался торфоподобным в течение всего периода исследования. (*Выводы*) Рекомендовали применять присыпку из биоугля и торфа для нейтрализации аммиака и неприятного запаха от навоза на зверофермах. Показали, что частота применения и толщина слоя смеси зависят от температуры окружающей среды, зимой присыпать навоз не требуется.

Ключевые слова: эмиссия, нейтрализация неприятного запаха, раздражающее воздействие, биоуголь, торф, животноводство.

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Agriculture is the most significant source of Ammonia emission that causes e.g. odour problems and loss of Nitrogen from agricultural systems. Manure is the main source of odour [1]. Odour causes local nuisance to the neighborhood. Litter and cover materials can be used in animal housing and in storage of manure to reduce both the odour problem and to tighten the nutrient cycles.

According to previous studies different covering materials can be used to reduce odour from manure storages (*Table*). According to a farm-scale study, that contains a fine lightweight powder that improves the density of the covering layer, was the most effective one [2]. Their results refer to that a dense surface cover reduces odour remarkably. In an laboratory study all other coverings tested reduced odour emissions significantly but thin layers of wood chips and wheat straw which were ineffective to reduce odour emissions [3].

Table

THE EFFECT OF DIFFERENT COVERING MATERIALS ON THE EMISSION OF AMMONIA AND ODOUR

Covering material	Layer thickness, mm	Reduction of odour, %	
		farm-scale	laboratory-scale
Chopped straw	50-150	83.8	–
Chopped wheat straw	70 140	– –	0 61
Maize stalks	70 140	– –	73 90
Perlite (Pegülit M)	100	93	–
Perlite (Pegülit R)	100	30	–
Wood chips	70 140	– –	30 55
Expanded clay	70 140	– –	75 69
Vegetable oil	3 9	– –	51 52
Tent roof	–	81.9	–

Peat is known as an effective cover material, but its use as a non-renewable resource is questionable whereas renewable biochar could have some additional benefits regarding e.g. the end-use of manure [4-6]. Biochar has the potential to bind nitrogen on its surfaces and slow the diffusion of gases from manure to the atmosphere [7]. The use of biochar as a litter for fur animal manure, as described in this paper, is a new innovation and possibility to minimize the emissions from fur animal farms. In a field study biochar was spread under the cages on a fur farm. The researchers noticed that it was possible to considerably reduce the odour if biochar was spread approximately every 10th day [8].

THE RESEARCH PURPOSE is to estimate the potential of a mixture of biochar and peat to reduce the odour from fur farms. The study was an experimental part of a project developing a novel way of recycling nutrients from fur farms.

MATERIALS AND METHODS. The potential of a mixture of biochar and peat for the odour control on farms was tested in a laboratory study. The test was carried out in the beginning of April 2018. The average temperature of the test chamber was 17.8°C ±2.9 and the average relative humidity 36.5% ±5.7. Mink manure was chosen to be used because of the common opinion that mink manure is more annoying than other manures. The mink manure used was fresh. It was collected directly from the farm on the same morning that the test was initiated. A 10 cm layer of manure was placed on the bottom of a 5 liter test bucket. The manure was covered with biochar-peat mixture (mixed in 50/50 ratio by volume) using five different covering thicknesses i.e. 0.5 cm; 1; 2; 3 and 5 cm. On top of these there was also a test bucket with 10 cm layer of mature compost of mixed fur manure (both mink and fox manure) included. Uncovered manure was used as a reference. Test buckets were covered with lids. The tests were performed in three replicates.

The odour emission was measured with an olfactometric method that is based on odour sensation of a person. Human nose is recognized to the best odour measuring devise because odour is a very subjective concept [9]. A Nasal Ranger field olfactometer was used (*Fig. 1*). The inset picture shows the dilution dial located at the air intake of the unit, which is unseen by the odor assessor during use (100% carbon filtered air blank positions are marked with arrows) [10]. According to a comparison test values obtained by field and laboratory olfactometry are consistent [11, 12]. The odour was expressed as odour concentration. The measuring range used for the dilution was from 2 to 500. In addition also the character of the odour was described.

To start with the odour measurements the lids were taken off one by one and the measurements were made

Fig. 1. The field olfactometer in use

Fig. 2. Arrangement for the measurement; lids were used on the buckets between measurements (left), the olfactometer placed tightly on the bucket during measurement (right)

right after the lid was taken off (*Fig. 2*). The inset picture shows the dilution dial located at the air intake of the unit, which is unseen by the odor assessor during use (100% carbon filtered air blank positions are marked with arrows) [12]. The measurements were performed right after the test buckets were ready, and after 1, 2 d 5 and 6 days from the beginning of the test. On days 5 and 6 the measurements were done also 1 hour after the lids were removed.

Results and Discussion. On the first measuring session the fresh manure was still cold and the odour measured was low. On the other measuring sessions the temperature of the manure had settled to the temperature of the chamber. According to the results a cover of 5 cm was able to prevent the odour from mink manure for the whole measuring period (*Fig. 3*) . The effect of 3 cm cover was able to reduce the annoying odour for 2 days. The effect of thinner coverings lasted only for one day.

The character of the odour was at first peat-like for all covered buckets but with thin coverings (0.5 cm and 1 cm) the odour was changed to more manure-like after 2 days as that of 2 cm covering remained peat-like until the 5th day. The odour from buckets with thicker coverings was peat-like during the whole test period of 6 days. The measured odour from mature fur manure compost was low and had no annoying odour at all. The characterization of the odour from the compost was during all the sessions decomposed and peat-like.

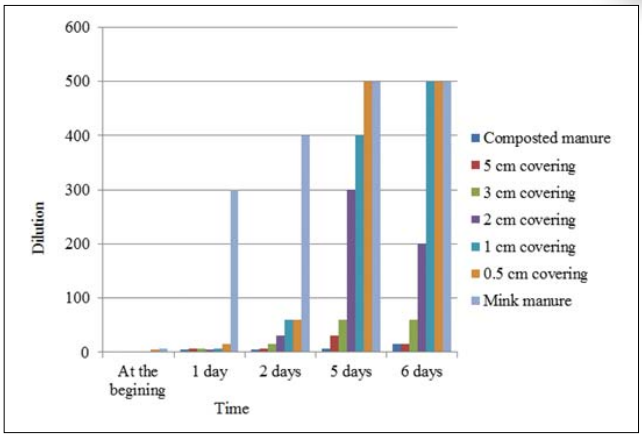

Fig. 3. Odour concentration measured from the covered and uncovered mink manure and also from the mature composted fur manure during the test period

The *m* ambient easurement on days 5 and 6 as the lids had been open for one hour showed reduction of odour on thin coverings and uncovered manure compared with the results of the just opened buckets (*Fig. 4*). The character of the odour was not changed due to opening the lids.

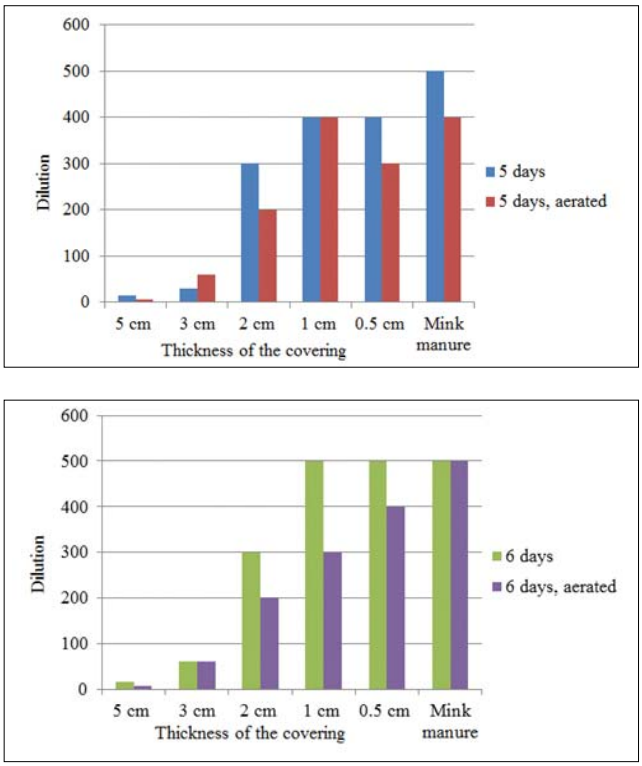

Fig. 4. Odour concentration measured from the covered and uncovered mink manure on days 5 (above) and 6 (below) just after the lids had been opened and 1 hour later

Conclusions. Biochar-peat covering reduced odour more the thicker the layer was. To reduce odour from fur manure a layer of 3 cm should be used and the adding of covering should be repeated every week. The relatively low humidity or ambient temperature in the test

chamber did not affect the results just like farm tests performed in Denmark [13]. On the other hand comparison of these emission values with other published odour emission values is difficult, due to the fact that there are only a few measurements done with fur animals and none of them focuses on manure storages.

The results, however, correspond to the measurements on gaseous emissions on fur farms in Finland which showed that a covering was able to reduce gaseous emissions and the beneficial effect of surface applied cover lasted for 7-10 days [14]. The results confirm also the observations of the field study [8] on the possibility to reduce odour from fur farms by using biochar. During cold periods as the temperature of the manure is very low or as the manure is frozen the odour level is much lower and covering of manure is not necessarily needed.

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