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Litter in horse keeping

At the Institute for Agricultural Engineering, University of Hohenheim five different littering products, all of them commonly used in horse stables, were investigated in practical and laboratory trials regarding use, moisture binding capacity, composting characteristics and nutrient content. Also determined were differences in the resultant manure qualities and discrepancies in the descriptions thereof in the literature.

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The choice of litter material in horse keeping depends on amount used, labour involved, amount of manure produced, the processing method and disposal costs. Investigated were cereal straw, hemp shavings, wood granules, fine and rough wood shavings with their required consumption and quantitative and qualitative influences on the horse manure. The trial featured the following investigations:

1. Litter volumes and moisture binding capacities
2. Quantitative litter use and daily manure production in practical conditions
3. Results of composting the manure in force-ventilated and free-ventilated containers with substrate analysis.

Litter volumes and moisture binding capacities

For this, 10 l of each litter type were measured out, weighed and filled in cylinder-form baskets then submerged in water for 24 h [1]. After another four hours weight differences were determined. Moisture binding capacity based on the litter weight was just over 300 wt % with cereal straw and hemp shavings and between 219 and 266 wt % for the wood products (*table 1*).

If one calculates moisture binding capacity in terms of litter volume then the moisture uptake of fine wood shavings is around 10 times, with wood granulate and hemp shavings around seven times, higher than cereal straw (*table 1*). With their high litter volumes, rough wood shavings and cereal straw are suitable more for regular complete mucking-out systems where a small amount of litter should cove a large area volume. The denser litter types such as fine wood shavings, wood granules and hemp shavings are to be recommended for the creation of a straw mattress because of their higher volume-based moisture binding capacities.

Litter use and manure production

For this investigation three horseboxes at a commercial stable were littered in the same way over a period of 14 days. Mucking-out was done twice daily by hand whereby in the morning all manure (faeces and wet litter) was removed and in the evenings only the faeces produced over the day. The manure produced per box was collected and weighed daily. Subsequent littering was done where required by the stable staff with the amount noted in the work journal. The amount of litter and manure per box was calculated per day (24 h) in relation to the length of occupation of the horses in the respective boxes during that time. The averages for seven trial days and three trial boxes per litter type are presented in *table 2*. Not taken into account at that stage were the sometimes-substantial variations which appeared in the results.

Comparatively limited daily litter consumption occurred with the complete dung removal system using fine wood shavings with only an average 5.3 kg per horse and day. The amount of manure produced lay in relationship to the type of litter with averages of from 46.5 to 58 kg per box and day. The manure volume produced each week – measured by the number of 1 m high piles – was almost double so much with cereal straw litter as with other types at 2.5 m^3. The relatively high litter and manure amounts are mainly to be explained through strictly applied complete cleaning when mucking-out. Not included in the calculation of the weekly manure volume is the volume reduction through degradation during manure storage. The recorded amounts are stable-specific and only partly transferable. They indicate, however, that the literature values should be replaced by actual data, a requirement which can be attributed to altered opinions on stable hygiene and to higher expectations from horse owners nowadays.

Table 1: Water absorption capacity, litter volume and specific amount of absorbed water by different litter substrates (height 0.24 m; volume 10 l)

Litter type	Moisture binding capacity [Wt. %]	Volume [l/kg]	Absorbed moisture [1/10 l litter]
Cereal straw	305	51,1	0,6
Fine wood shavings	266	4,4	6,1
Rough wood shavings	242	14,8	1,6
Wood granules	219	5,2	4,2
Hemp shavings	325	8,1	4,0

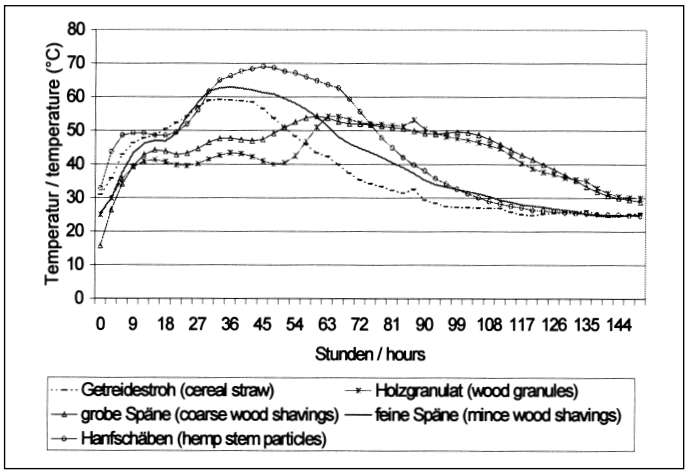

Fig. 1:Temperature course of horse dung with different litter materials in forced ventilated composting

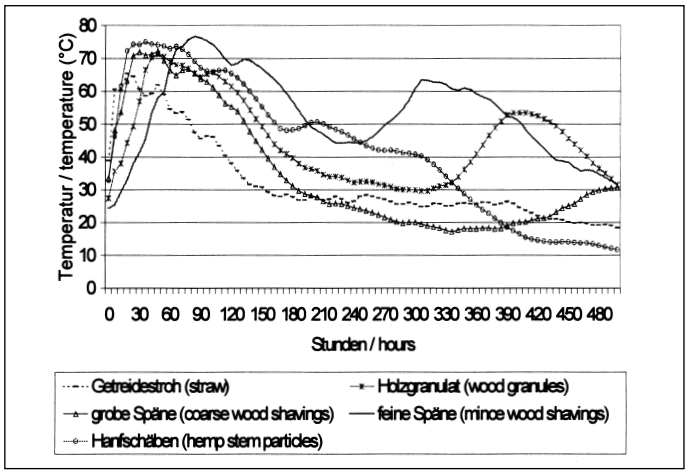

Fig. 2: Temperature course of horse dung with different litter materials in a free ventilated composting

Composting

For this the daily produced manure from each similarly littered trial box was collected and mixed. Each litter variant was chopped smaller, homogenised and then with a dm content of 35% filled in each case into three force-ventilated [2] (net volume: 35.8 l) and three free-ventilated [1] (net volume: 250 l) insulated reactors for composting. The types of manure were then compared based on temperature process and alterations in litter characteristics. With the forced ventilation composting carried out in the laboratory, the concentrations of O_2, CO_2 and NH_3 in the exhaust air were also recorded and integrated in the evaluations. The end product compost was analysed for major nutrients and heavy metal content [3]; the temperature curves and nutrient contents are presented below.

Because of the steep rise in temperature (*fig. 1*) and gas concentrations in exhaust air [3], the force-ventilation composting of manure from hemp shavings, fine wood shavings and cereal straw led to a more rapid degradation in comparison to manure from wood granules or rough wood shavings. With the free-ventilated containers (*fig. 2*) the substrate temperature curves indicated that the breakdown of litter in the manure with cereal straw and hemp shavings took place faster than in manures with wood substrates. Less lignin content compared with the wood substrates led to an almost continuous nutritive substances and energy availability for the microorganisms. The cereal straw manure dried out to a great extent during the composting which is why it showed a lower temperature level. With the wood products a second temperature rise took place caused by re-charging of the microbial degradation process following the beginning of the breakdown of lignin encrusted crude fibre. Here the production of nutrient substances from fine wood shavings through wood granules to rough wood shavings was increasingly slowed down with intensity of processing undergone and fineness of substances having a positive effect.

Regarding macronutrients N, P, K and the pH, the investigated horse manure composts were well placed in biowaste compost list of the LAGA Information leaflet M 10 (1995). However, compared to composted cattle solid manure [4] nutrient content is much lower (*table 3*).

With the force-ventilated composting of manure with cereal straw an increase averaging 13% in absolute total nitrogen content could be determined. In this case the wide C/N relationship of 50:1 and the good carbon availability meant that atmospheric nitrogen could be microbially fixed.

Litter type	Cereal straw	Wood granules	Rough wood shavings	Fine shavings	Hemp-shavings
Amount of litter [kg/horse •day]	10.8 (9.6 - 12.7)	9.0 (5.8 - 12.3)	10.6 (8.6 - 13.4)	5.3 (3.2 - 6.6)	10.0 (8.6 - 11.8)
Amount of dung [kg/horse •day]	47.7 (37.1 - 58.7)	58.0 (42.9 - 74.7)	48.3 (45.3 - 53.1)	46.5 (35.0 - 55.6)	48.0 (46.0 - 49.1)
Storage density of dung [kg/m³]	132.8	325.2	210.4	272.0	259.2
Dung volume / week (m³/horse)	2.5	1.25	1.61	1.20	1.30

Table 2: Average amounts of litter and dung from three boxes each for 7 experimental days (minimum and maximum results in brackets)

Table 3: Nutrients contents and pH-value of compost from horse dung with different litter substrates, compared to composts from cattle dung and bio wastes

Parameter	dm (%)	odm (%dm)	N_{geg} (%dm)	P_2O_5 (%dm)	K_2O (%dm)	pH-value	Author
Biowaste compost	50 - 65	25 - 45	0.8 - 1.5	0.4 - 1.0	0.6 - 1.5	7.0 - 8.3	LAGA (1995)
Cattle solid manure compost	32	71	2.9	2.1	7.6	9.1	CSEHI (1997)
Horse manure compost	26 - 48	88 - 94	0.7 - 1.5	0.5 - 1.8	1.9 - 6.0	7.2 - 9.0	Own figures

Literature

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