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Characterization of Humic Fertilizers from Horse, Sheep and Cattle Dung by their Density

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Significant differences in the humification products of horse, sheep and cattle dung can be identified by determining their density. Furthermore, the degradation rates of composts and peats can be determined with this method.

Key Words: Humic fertilizers, Horse, Sheep and Cattle Dung.

INTRODUCTION

Horse and sheep dung are fast-acting fertilizers, whereas cattle dung is a slow-acting fertilizer[1]. The former are therefore labeled hot fertilizers and cattle dung is known as a cold fertilizer. Consequently, horse and sheep dung needs 2 to 3 months before optimum application, whereas cattle dung needs around 2 years[1].

The progress of humification of these base materials can be monitored by temperature measurements[2], determination of the degradation rate[3] and the C/N ratio[4]. Determination of density is also a suitable way of identifying the practical value of these forms of fertilizer[5]. The density of humic substances is a highly reliable indicator. Podzol soil samples have a density of 1.5 g/cm^3, brown coal samples 1.35 g/cm^3 and black peat samples 1.68 g/cm^3. With this analytical approach, it is also easily possible to derive a correlation with related natural substances or products of the carbonization process[5,6] (Fig. 1).

EXPERIMENTAL

For each of above-mentioned samples, 10 parallel samples were used. Throughout the 10-weeks period, the samples were kept in the optimum humidity range of 50 % (approximately at field capacity). Within this period, density measurements were performed on a weekly basis by means of a pycnometer at a constant temperature of 23°C.

To achieve this, the true weight of the pycnometer (u) was weighed first. The vessel was then filled with distilled water and weighed again (v). The volume (V) of the pycnometer at the density (ρ) of the water is 0.9975 g/cm^3 (at 23°C):

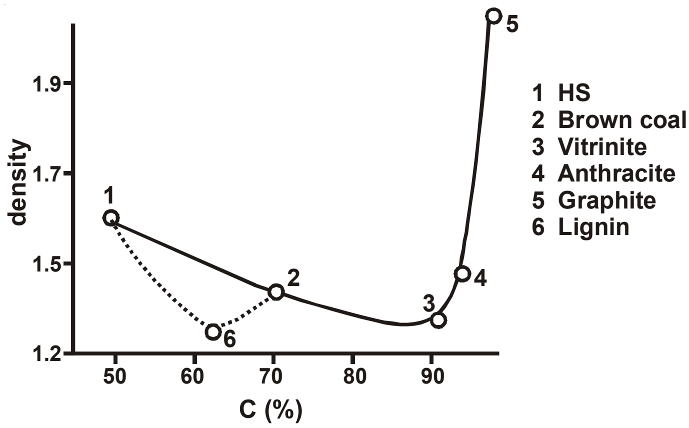

Fig. 1. Density of humic substances and related substances according to carbon content

$$\frac{v-u}{\rho} = V(cm^3).\text{Volume of the pycnometer}$$

where, V = Pycnometer filled with water.

Each time, 2.000 g of sieved (5 mesh) air-dried samples was weighed in the pycnometer and topped up with water. The pycnometer was then evacuated until no more air bubbles arose, filled with water and evacuated again until no more volume change due to escaping gas occurred, before being weighed (W).

The volume of the sample (Vp) is calculated according to the following formula:

$$V - \frac{W-(u+\text{weighed sample})}{\rho} = Vp(cm^3)\ \text{Sample volume}$$

This produces the sample density[7] ρ_p:

$$\frac{\text{Weighed sample}}{Vp} = \rho_p\left(\frac{g}{cm^3}\right)\text{Sample density}$$

RESULTS AND DISCUSSION

The results of the density determinations are reproduced in Table-1.

The changes to the densities with the humification time are very similar in horse and sheep dung as a base material (Fig. 2). In both, the density changes only slightly from week 7 onwards. The progression is reminiscent of a biological reaction curve, which is obviously in line with the general laws of humification.

TABLE-1
DENSITIES (g/cm^3) OF THE HUMIFICATION PRODUCTS OF HORSE, SHEEP AND CATTLE DUNG BY RISING HUMIFICATION TIME

Animal	No. of weeks									
	1	2	3	4	5	6	7	8	9	10
Horse	1.63 ± 0.03	1.72 ± 0.05	1.84 ± 0.04	2.02 ± 0.07	2.05 ± 0.04	2.07 ± 0.08	2.11 ± 0.03	2.12 ± 0.07	2.18 ± 0.06	2.19 ± 0.04
Sheep	1.20 ± 0.02	1.30 ± 0.06	1.40 ± 0.04	1.50 ± 0.03	1.60 ± 0.05	1.70 ± 0.03	1.72 ± 0.07	1.74 ± 0.08	1.76 ± 0.05	1.79 ± 0.04
Cattle	1.20 ± 0.05	1.20 ± 0.04	1.20 ± 0.08	1.20 ± 0.03	1.20 ± 0.02	1.20 ± 0.07	1.20 ± 0.03	1.20 ± 0.06	1.20 ± 0.02	1.20 ± 0.08

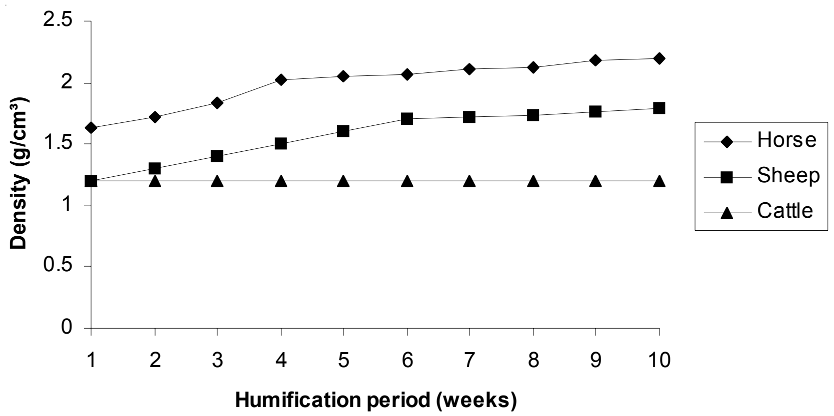

Fig. 2. Change in density of the dung during a humification period of 10 weeks in the optimum humidity range of 50 % at room temperature

The 1st section relates to the radical phase of humic substance formation, during which larger particles are quickly formed from low-molecular portions by means of main valence bonds (*via* radicals). The products thus obtained gain increased stability at a pronounced density gradient[5,6].

In the 2nd section, intermolecular forces occur that lead to larger but less compact particles as a result of their lower binding energy. Consequently, the density changes to a lesser extent, and a saturation level is ultimately reached.

In addition, it is clear that in cattle dung, there is hardly any change in density during the experiment period and the differentiation of the base materials explained above and demonstrated in practice is thus thoroughly confirmed. The density of the product obtained from horse dung appears to be abnormally high, as values of around 0.8-1.2 g/cm^3 (Fig. 1) are generally measured for humic substances in the initial phase[7,8].

This deviation indicates that humification has already taken place in the intestine (clearly much more intensively than was the case in sheep), further evidence that humic substance formation does not only occur in soil. Such a finding is not at all surprising after Khairy[9] proved the formation of humic materials in human feces.

In conjunction with the degradation rate[3], this simple method makes it possible to identify these fertilizers primarily in order to derive realistic information regarding their time of use.

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