

Meeting Report

Geoffrey Davies (Northeastern Univ.) Properties and Functions of Humic Acids

Presented at the January meeting of the Northeastern Section

Report prepared by Geoffrey Davies

Humic substances (HS) exist throughout nature as brown or black organic polymers with average <MW> from 1500 to >100,000 Da. Smaller organic molecules polymerize to give lignins, HS, peats, and coal whose structures depend on the feedstock and polymerization conditions at the source.¹

HS have four main fractions: **Fulvic acids (FA)** dissolve in natural waters and at high or low pH. Their highest <MW> is about 500 Da; **Hymatomelanin acids (HY)** are soluble in small alcohols. Their <MW> range is 5,000-11,000 Da; **Humic acids (HA)** precipitate from aqueous solution on reducing the pH to 1. They are insoluble in small alcohols and in water below pH 8. Their lowest <MW> is about 12,000 Da; **Humins** is insoluble in water at any pH, has much lower adsorptive power than HA and <MW> is at least 70,000 Da. Humin is further along toward peats, coals and graphite.¹

HA are immobilized by their insolubility and regulate environmental processes. They are found especially in soils and water sediments. HA impart porosity and act as adsorbents and reservoirs of water, plant nutrients, metals, herbicides, pesticides, and other soil and sediment components.¹ As such, HA are crucial environmental materials. However, understanding their functions requires a much better understanding of their structures.

HA were thought only to result from plant and animal decay under moist conditions in a process called humification. However, we have isolated HA from a living plant, (*Pilayella littoralis*)² and are searching

for HA in other live plants. The surface areas of HA samples extracted from kelp are increased by supercritical fluid drying.³ Biomass that contains HA or is easily composted is valuable for soil creation, improvement and remediation.

HA also are found in the gastrointestinal tract of humans and animals and HA are absorbed by animals.⁴ They circulate with the blood⁵ and are metabolized in the liver.⁶ Oral doses of HA reduce heavy metal adsorption in animals⁷ and also decrease pesticide toxicity.⁸ HA can be administered prophylactically and therapeutically in animals, including pregnant animals, without apparent risk.⁹ Some HA control uterine cancer in rats¹⁰ and HA markedly reduce the mutagenic effect of benzopyrene, 3-aminoanthracene, 2-nitrofluorene and 1-nitro-pyrene.¹¹ The desmutagenic effect depends on adsorption of these dangerous chemicals on the HA surface.¹² A recent volume clearly links HA properties with human health.¹³

There seems to be natural control of the growth and functions of HA. This talk described new ideas about their structures¹⁴ and presented evidence for specific adsorption of solutes by distinct HA sites.¹⁵

References

¹Zechmann, W., *Humic Substances*; BI Wissenschaftsverlag, Mannheim, 1993.

²Ghabbour, E.A.; Khairy, A.H.; Cheney, D.P.; Gross, V.; Davies, G.; Gilbert, T.R.; Zhang, X., *J. Appl. Physiol.*, 1994, 6, 459.

³Davies, G.; Radwan, A.; Rouanet, S.; Willey, R.J., *in preparation*.

⁴Khairy, A.H., *Acta Medica Empirica*, 1981, 11, 898; Khairy, A.H., *De Natura Rerum*, 1989, 3, 229; Khairy, A.H.; El-Gendi, S.S.; Bhagdadi, H.H., *De Natura Rerum*, 1991, 5, 76.

⁵Klockling, R.; Eichhorn, U.; Blumohr, T., *Fres. Z. Anal. Chem.*, 1978, 292, 408.

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Committee Chairmen for 1996

Additional appointments to follow

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Continuing Education: Alfred Viola

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*Elected committees or *ex officio* chairmen. ◊

Board of Directors

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Chemists course had been filled for November 18 and that he was offering a repeat of the course in January to accommodate the overflow.

Nominating: The committee presented nominations for election to the Board of Directors as members-at-large in accordance with the recently approved amendments. Those elected are to serve until the next annual election. The board VOTED to elect the slate as presented. Accordingly, the slate (see above) will serve as members-at-large, subject to their acceptance. ◊