The use of Montmorillonite and other aluminosilicates as food supplements for Humans and Horses. (Research Compilation)

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The use of aluminosilicates, such as montmorillonite (bentonite), illite, zeolite and others, has been in practice for humans and animals alike, for hundreds (if not thousands) of years. The term that describes the feeding of these clays is known as Geophagy (eating dirt). *(-Hunter, John M. "Geophagy in Africa and in the United States: A Culture-Nutrition Hypothesis." Geographical Review April 1973: 170-195. -Jordan, Terry G. and Lester Rowntree. "The Human Mosaic: A Thematic Introduction to Cultural Geography". New York: Harper & Row Publishers, 1990.)*

Occasionally they were prescribed by the medicine–men of different tribes and populations, of areas where some of these specifically benign clays were found. The specific geographical location of some of the best quality clays gave origin to some of the popular names by which they are called. One example is the Bentonite from Fort Benton, Wyoming, USA; or the Montmorillonite from Montmorillon, France. *(Faïza Bergaya. CNRS Centre de Recherche sur la Matière Divisée; 1 b rue de la Ferollerie; F-45071 Orléans cedex 2. Klaus Beneke and Gerhard Lagaly Institute of Inorganic Chemistry; Christian-Albrechts-University; D-24098 Kiel.)*

Although the commercial name is different, in reality they are the same basic aluminosilicate structure; of the Smectite Group» *(Laird, D.A., P. Barak, E.A. Nater, and R.H. Dowdy. 1991. "Chemistry of smectitic and illitic phases in interstratified soil smectite". Soil Science Society of America Journal 55:1499-1504.)*

Traditionally, it was thought that the absorbing power of montmorillonite could slow down or cure diarrhea. *(Bentonite: Public Research Project. 1995.)* Different accounts in the literature suggest that there is a correlation between the administration of bentonite and the reduction of the pathogenic capabilities of several types of bacteria, including *E. Coli, Staphylococcus Aureus, Proteus Mirabilis and Serratia Marcescens.* In tests performed in the sixties in humans, this was observed and recorded by Dr. Howard E. Lind, M.S., BS, Ph.D. *(MEDICAL ANNALS of the DISTRICT OF COLUMBIA, Vol. 20, No. 6, June, 1961.)*

In some areas where cattle was raised, when a food related disease of unknown origin would take place, instead of investing in unaffordable treatments, the sick animals were released to feed on their own, as opposed to being fed artificially with the rest of the herd. These animals would return after several days, showing an astonishing recovery. This prompted the farmers to follow the sick animals, to observe what was happening after their release. What they saw was that the sick animals would travel, sometimes long distances, until they would find an area where clay would be available. After feeding several days on it, they would recover and return to their original herd on their own. *(Mahaney,W C, Maximilliano, B Hancock, RGV Aufrieter, S and Perez, FL 1996. "Geophagy of Holstein hybrid cattle in the northern Andes", Venezuela. Mountain Research and Development, 16 (2) pp 177-180.)*

According to the local tradition, something similar happened to the mules of the gold fever

era miners that traveled through certain areas of eastern Nevada, USA; where some interesting deposits of Bentonite were found. It was said that the mules would throw their heads down to the ground, eating clay during a couple of days; after which they would be ready to continue their journey. *(Dr. Melchior Dikkers. Loyola University. "The Trace Mineral Story".)*

As more information was available on the administration of these minerals to animals, more studies were conducted by different entities, including many laboratories, universities and private professionals. This has led to varied results. So varied, that the FDA considers the montmorillonite as GRAS (generally recognized as safe) when it is used as an additive for feed stuffs, but doesn't recognize it as GRAS for its absorption capabilities on bacteria and toxins; although many studies and physicochemical evidence, suggests that this is the case.

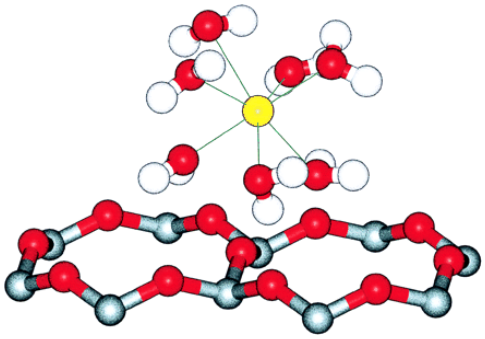
"A major research effort is the ongoing development and molecular characterization of toxin- and microbe-selective enterosorbents for the chemo-prevention of food-borne disease, including aflatoxicosis. One of these enterosorbents for aflatoxins (i.e., NovaSil clay), when included in the diets of farm animals, has been shown to diminish aflatoxin exposure and toxicity. Dr. Phillips' has also recently demonstrated the significant sorption and inactivation of *Salmonella Enteritidis* and *E. Coli* bacteria using a chemically-modified montmorillonite clay". *(Dr. Timothy Phillips, Ph.D. College of Veterinary Medicine, Texas A&M Universit, y College Station, TX 77843-4458.)*

Recent work has shown that the double hydroxide clays (anionic clays) can incorporate DNA molecules in their interlayer and provide a suitable drug carrier for the gene therapy treatment of leukemia *(Choy et al., 2000).* Intercalated clays have also been shown to be effective carriers in the gastrointestinal release of selected cationic drugs *(Fejer et al., 2001)* including chemotherapeutic treatment of colorectal cancer (Lin et al., 2002*) (Randall T. Cygan. Interactions of Biomolecules with Clay-Minerals).*

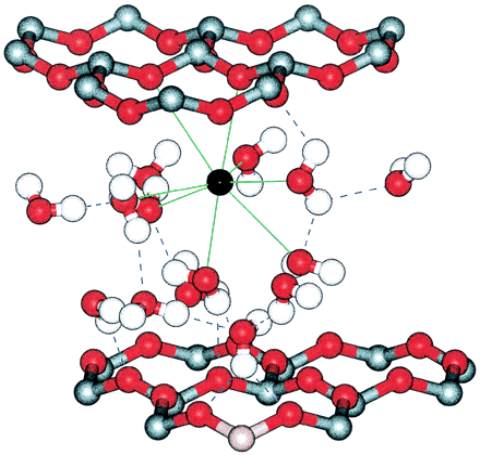
To illustrate this, a simple review of the absorptive and adsorptive capabilities of the basic aluminosilicate tetra or octahedral configurations is needed.

Montmorillonite: ≈ $Na_x(Al_{2-x}Mg_x)Si_4O_{10}(OH)_2$

a).



b).



The above diagrams show us two options. The first: (a), is the monolayer presentation, which has the positively charged particles internally, exposing the negatively charged areas. This allows the adsorption of positively charged elements to it.

The second: (b), is the double layer presentation, which has a negatively charged inner space, with a positively charged outer area. This allows the absorption of positively charged elements and particles to the negatively charged inner space; and the adsorption of other negatively charged elements and particles to the positively charged exterior layer. *("Surface geochemistry of the clay minerals". Garrison Sposito, Neal T. Skipper, Rebecca Sutton*, Sung-ho Park*, Alan K. Soper, and Jeffery A. Greathouse). ("SPECIATION OF ALUMlNUM IN HYDROXYALUMlNUM AND HYDROXYALUMINOSILICATE IONS FIXED BY MONTMORILLONITE, USlNG 27Al-NMR AND ICP-AES". Satoru Taniguchi, Syuntaro Hiradate and Katsutoshi Sakurai).*

The negatively charged areas are responsible for the elimination through absorption and adsorption, of different heavy metals, when they are positively charged. *(Heike Bradl, Umwelt-Campus Birkenfeld University of Applied Sciences. Trier. Birkenfeld, D55761, Germany.) (Hennig C., Reich T., Dähn R., and Scheidegger A. M. (2002) "Structure of uranium sorption complexes at montmorillonite edge sites". Radiochim. Acta 90, 653-657.)*

Other interesting data is related to the capacity of the aluminosilicates to travel through the gastrointestinal tract as such, without deteriorating or braking the aluminosilicate molecule; which would presuppose an intestinal absorption of the basic components: aluminum and silica.

«The chemical bond of the montmorillonite aluminosilicate is very strong» (*Clay and the Origins of Life. Liz Vrolyk, July 2000.)*

According to Dr. Robert Bickmore *(Bickmore, Barry Robert, PhD. "Atomic Force Microscopy Study of Clay Mineral Dissolution". 1999.)*, the pH necessary to dissociate the aluminum from the aluminosilicate, would have to be lower than 2.
At the same time, the pH necessary to dissociate the Silica from the aluminosilicate would need to be alkaline: above 7. *(Laura Crossey. "Sedimentary Geochemistry": 2001. Geochemistry Overview.)*

Practically speaking, in most herbivores and men, those conditions of pH are not found when administering a buffer salt that regulates it; unless there is a pathological environment. In physiological conditions, the pH in the stomach is usually above 2. The intestinal pH, where most of the minerals are absorbed, rarely surpasses 7. *("EFFECTS OF ORAL ADMINISTRATION OF LACTULOSE IN HEALTHY HORSES". W. Kent Scarratt, DVM; Lorin D. Warnick, DVM, PhD.)*

Therefore, the possibility that the montmorillonite would dissociate into large amounts of aluminum and silica doesn't seem to be feasible, in normal conditions.

Some availability could occur from the presence of these, originated from their uncombined valences, at the terminal portions of each layer. *("Modifications of the Hydrophilicity of Clay Minerals by Adsorption of Metals Ions and Humic Substances". J.-C, Hsiung*, T.B.L.Lloyd and R.A.Pearson; Lehigh University, *Department of Materials Science and Engineering, **Department of Chemistry, Bethlehem, PA 18015.) (Dähn R., Scheidegger A. M., Manceau A., Schlegel M. L., Baeyens B., Bradbury M. H., and Chateigner D. (2003) "Structural evidence for the sorption of Ni(II) atoms on the edges of montmorillonite clay minerals. A polarized X-ray absorption fine structure.)*

This would account for the absorption of a small amount of these elements, which have been recently considered as essential. *(Trace Mineral Supplementation and The Effect On Total Nutrient Serum Levels".) STEVEN E WHITING, Ph.D. - Department of Research and Product Evaluation, The Institute of Nutritional Science, San Diego, CA, USA 92103 April - September, 1993.)*

After reviewing these facts, it seems reasonable to conclude that the presence of an aluminosilicate such as montmorillonite in the diet of a horse would not be able to cause the absorption of an abnormal quantity of neither of the two basic elements.

Although the majority of these aluminosilicates contain many different elements adsorbed and absorbed in it, including heavy metals, it is common to find deposits, which have organic components in their structure, such as humin, humic acid and fulvic acid. *("Unearthing the Structure of Humic Substances". Research conducted by S.C.B. Myneni (Princeton University, Berkeley Lab), J.T. Brown, W. Meyer-Ilse (Berkeley Lab), and G.A. Martinez (University of Puerto Rico). Research Funding: Laboratory Directed Research and Development program, Berkeley Lab; Office of Basic Energy Sciences (BES), U.S. Department of Energy. Operation of the ALS is supported by BES. Publication about this research: S.C.B. Myneni, J.T. Brown, G.A. Martinez, and W. Meyer-Ilse, "Imaging of Humic Substance Macromolecular Structures in Water and Soils," Science 286, 1335-1337 (1999.)*

These are a source of chelation, which renders those heavy metals practically innocuous. *("Adsorption of Heavy Metal Ions on Soil Surfaces and Similar Substances". Resat Apak. Istanbul University, Avcl/ar Istanbul, Turkey.) ("Interaction of organic compounds with NOM Role of Lipids in the Binding of Contaminants to Humin". James A. Rice* and Scott D. Kohl. Department of Chemistry and Biochemistry, South Dakota State, Box 2202, Brookings, SD.) ("Effects of Fulvic Acids on Lead Uptake and Transport by Sunflowers". S.A. Spigarelli* and W.J. Bombardier. Center for Environmental Studies, Bemidji State University, 1500, Birchmont Dr NE, Bemidji, Minnesota 56601.) ("Sulfur in Biosolids Fulvic Acid: Characterization by XANES. Spectroscopy and Wet-Chemical Analyses". L.S. Hundal*1, A.M. Carmo1, W.L. Bleam2, M.L. Thompson. 1 Agronomy Department, Iowa State University, Ames, Iowa 50011-1010. 2 Department of Soil, University of Wisconsin-Madison, Madison, WI 53706-1299)*

According to Dr. Aria Amirbahman *(Professor of the University of Maine, Related Studies, 2003.),* the presence of free mercury, lead, arsenic and iron is very low; almost unidentifiable, when these humic elements are present.

The continuous exposure to this kind of aluminosilicate to horses has not yielded negative results, after years of supplementing two ounces daily. *(The use of naturally chelated trace minerals as an aid to prevent and treat laminitis and founder, and as a supplement)* (www.laminitisprevention.com). One possible exception, is a known case of a horse with a chronic renal condition, which was worsened by the administration of this salt, possibly by an overload during the excretion. Before this particular case, this condition had not been observed. Although the incidence is very low, the addition of any salt should be carefully considered to avoid a relapse when a case like this appears.

To the contrary, many beneficial effects have been observed, including a visible decrease in laminitis cases, the improvement of the overall health and condition of the horses supplemented (increased mesodermal stimulation due to the silica content) and an improvement on the conversion rate of the food. *(The use of naturally chelated trace minerals as an aid to prevent and treat laminitis and founder, and as a supplement)* (www.laminitisprevention.com)

Not only the above mentioned elements are provided by the humic montmorillonite compounds, but also a considerable number of trace elements, that as progress is made in the field, are proving to have a positive impact in the animal health. *(Jackson, William R., Ph. D. (1995). p. 261-282 "Humic, Fulvic and Microbial Balance": Organic Soil Condition. Evergreen, Colorado.) (Uthus EO, Seaborn CD. "Deliberations and evaluations of the approaches, endpoints and paradigms for dietary recommendations of the other trace elements". J Nutr 126:2452S-2459S. 1996.)*

Curiously, not long too ago the silica was not considered required. Studies again have shown the need for this trace element in bone and connective-fiber tissue formation. *("Silicon and Equine Bone Health". BrianD.Nielsen, Ph.D.,PAS, Dpl. ACAN. Kari E. Krick, M.S.) ("Silicon's Elemental Benefits", by C. Leigh Broadhurst, Ph.D.)*

Furthermore, it has been proven not to be toxic to domestic animals, when used at the recommended doses. *(Seaborn, C.D. & Nielsen, F. H. (1993) "Silicon: A nutritional beneficence for bones, brains and blood vessels?" Nutr. Today 28: 13-18.), (Nielsen, F. H. (1999) "Other trace elements. In: Modern Nutrition in Health and Disease". (Shils, M. E., Olson, J. A., Shike, M. & Ross, C. A., eds.), 9th ed., pp. 283-304. Williams & Wilkins, Baltimore, MD.)(Elmore AR; Cosmetic Ingredient Review Expert Panel." Final report on the safety assessment of aluminum silicate, calcium silicate, magnesium aluminum silicate, magnesium silicate, magnesium trisilicate, sodium magnesium silicate, zirconium silicate, attapulgite, bentonite, Fuller's earth, hectorite, kaolin, lithium magnesium silicate, lithium magnesium sodium silicate, montmorillonite, pyrophyllite, and zeolite".)*

Aluminum, on the other hand, has been a controversial element to consider, since a link has been made to the damage of nerve tissues, with concentrations considered elevated, after kidney dialysis aluminum instruments were used. *("TRANSFERRIN AS A METAL ION CARRIER". Prof. Peter Sadler; Hongyan Li.)*

Research has shown that aluminum absorbs best in rats, in the presence of citrate as an additive. *("Mechanisms of aluminum absorption in rats. MW Whitehead, G Farrar, GL Christie, JA Blair, RP*

Thompson and JJ Powell, Gastrointestinal Laboratory, Rayne Institute, St Thomas' Hospital, London, United Kingdom".)

A definite link between Aluminum and Alzheimer's has not been proved yet. *"While there are several laboratories still exploring the possible connection between heavy metals and brain disease, most investigators now believe that aluminum and other metals accumulate in dying cells, and thus the higher aluminum content in the Alzheimer's brain is the result, rather than the cause, of the condition."* *(Kenneth Minaker, M.D., Chief of the Geriatric Medicine Unit and director of the MGH Beacon Hill Geriatric Health Practice at Massachusetts General Hospital. Fellow of the Royal College of Physicians and Surgeons of Canada, Certificate of Special Competence in Geriatric Medicine.2002.)*

The need for small doses of aluminum in the diet has been recorded. *(Uthus EO, Seaborn CD. "Deliberations and evaluations of the approaches, endpoints and paradigms for dietary recommendations of the other trace elements". J Nutr 126:2452S-2459S. 1996.)*

This kind of aluminum would be of the metallic type; or free, or ionic. *("Formation of layered single and double metal hydroxide precipitates at the mineral/water interface: A multiple-scattering XAFS analysis". Scheinost, A.C., and Sparks, D.L. University of Delaware.)*

Since most of this element would not be free to associate, while being found as part of the aluminosilicate molecule, the incidence of diseases caused by aluminum accumulation, is not likely to originate from the supplementation of montmorillonite and other types of aluminosilicate compounds. Studies show that probably less, if there are humic materials also present. *("Modifications of the Hydrophilicity of Clay Minerals by Adsorption of Metals Ions and Humic Substances". J.-C, Hsiung*, T.B.Lloyd**, and R.A.Pearson*; Lehigh University, *Department of Materials Science and Engineering, **Department of Chemistry, Bethlehem, PA 18015.)*

Other described actions of comparable humic molecules include an anti-oxidant effect *("Antioxidant defense by native and processed Shilajit-A comparative study". Indian journal of Chemistry.Vol. 35B, Feb. 1996, pg. 127-132.) (Effects of Shilajit on biogenic free radicals. Phytotherapy Research, Vol. 9, pp 56-59 (1995) Salil K. Bhattacharya and Ananda P. Sen. Dept. of Pharmacology, Instituite of Medical Sciences, Banaras Hindu University, Varanasi-221005, India.) (Free radical scavenging activity of water-soluble fullenerols. Long Y Chiang, Fung-Jou, Lu and Chang-Wu, Tsai (1995) J. Chem. Soc. Chem. Commun.1283-1284.)* and an antitoxic effect. *("3. Adsorbent Compounds as Feed Additives to Reduce Mycotoxin Bioavailability". European Mycotoxin Awareness Network.)*

After reviewing the previous data is seems reasonably certain to conclude that the use of montmorillonite and other specific aluminosilicates are in fact safe to use as supplements for horses and do not post any health threat when administered for an extended period of time, under the recommended doses. Furthermore, in some specific cases, they seem to be necessary. The valued source of many rare trace minerals that are transported within this type of aluminosilicate natural carrier cannot be compared with any other artificial formulation. Although the trace amounts of the minerals associated with the montmorillonite in many cases are not high enough to cover a deficiency, the mere presence of these many elements ensures a sufficient supply to diminish or prevent those rare trace mineral deficiencies; while exerting its powerful absorptive capabilities over aflatoxins and other types of toxic elements.