

# Zeolite Research & Scientific Papers on Clinoptilolite

The safety and toxicity is of primary concern to all consumers. Here is a small selection of some of the scientific papers and abstracts sharing the knowledge that Clinoptilolite is safe to consume and has no toxic side effects. After years of vigorous research there are now over 200 scientific papers that have been published. Click on links to the specific scientific paper abstracts. The numerous research papers over many years demonstrate that Clinoptilolite is safe and non-toxic and we hope that medical practitioners and their patients review some of these papers.

## *Enterex: Anti-diarrheic drug based on purified natural clinoptilolite*

Clinoptilolite has been approved for use as an anti-diarrheic drug. Enterex: Anti-diarrheic drug based on purified natural clinoptilolite

G. Rodriguez-Fuentes, M.A. Barrios, A. Iraizoz, I. Perdomo and B. Cedré

Zeolites Volume 19, Issues 5–6, November–December 1997, Pages 441–448

**Abstract:** A new anti-diarrheic drug for humans has been developed based on the physical and chemical properties of the purified natural clinoptilolite NZ. A series of physical, chemical, technological, pharmacological, microbiological, and clinical studies were successfully conducted to meet the requirements of the Cuban Drug Quality Agency. The most important results concerning the properties and biological mechanism of NZ are described in this paper.

## *Antiviral properties of clinoptilolite*

Antiviral properties of clinoptilolite of this study suggest that there is a therapeutic case for clinoptilolite against the herpes virus.

Magdalena Grce, and Kreimir Pavelic

Microporous and Mesoporous Materials. Volume 79, Issues 1–3, 1 April 2005, Pages 165–169

**Abstract:** The aim of this study was to evaluate the antiviral properties of clinoptilolite, a natural non-toxic zeolite. Herein, a fine powder of micronized zeolite (MZ) was obtained by tribomechanical micronization of natural clinoptilolite. Different viral suspensions were treated with MZ in concentrations ranging from 0.5 to 50 mg/ml. The viral proliferation was evaluated by optical microscope as percentage of cytopathic effect (CPE). Human adenovirus 5, herpes simplex virus type 1 (HSV 1) and human enteroviruses (coxsackievirus B5 and echovirus 7) were used in the antiviral assay. Concentrations of 0.5 and 5 mg/ml of MZ induced a very low antiviral effect or the antiviral was not observed at all, while concentrations of 12, 25 and 50 mg/ml of MZ induced a significant inhibitory effect upon viral proliferation. MZ inhibited the viral proliferation of HSV 1, coxsackievirus B5 and echovirus 7 more efficiently than adenovirus 5. The antiviral effect of MZ seems to be non-specific and is more likely based on the incorporation of viral particles into pores of MZ aggregates than ion exchange properties of clinoptilolite. Our preliminary results indicate a possibility of therapeutic application of MZ, either locally (skin) against herpesvirus infections or orally in cases of adenovirus or enterovirus infections. Furthermore, MZ could also be used in purification of drinking water from different viruses.

## *Anticancer and antioxidative effects of micronized zeolite clinoptilolite.*

The anticancer and antioxidative effects of micronized zeolite clinoptilolite showed a reduction in the cancer count

Zarkovic N, Zarkovic K, Kralj M, Borovic S, Sabolovic S, Blazi MP

Anticancer Res. 2003 Mar-Apr;23(2B):1589-95.

## **Abstract**

### **BACKGROUND:**

Treatment of cancer-bearing mice and dogs with micronized zeolite clinoptilolite (MZ) led to improvement of the overall health status, prolongation of life span and decrease of tumor size in some cases. It also reduced lipid peroxidation in the liver of mice.

### **MATERIALS AND METHODS:**

The experiments were performed on various tumor cell cultures and tumor-bearing animals. Immunohistochemistry was used to analyze if MZ could interfere with Doxorubicin-induced lipid peroxidation and consequential production of 4-hydroxynonenal (HNE).

### **RESULTS:**

MZ reduced the metabolic rate of cancer cells and increased binding of HNE to albumin in vitro. It selectively reduced generation of HNE in vivo in tumor stroma after Doxorubicin treatment leaving onset of lipid peroxidation intact in malignant cells. Combined treatment with Doxorubicin and MZ resulted in strong reduction of the pulmonary metastasis count increasing anticancer effects of Doxorubicin.

### **CONCLUSION:**

Interference of MZ with lipid peroxidation might explain some of the beneficial effects of this particular zeolite in combined cancer therapy.

#### *Natural zeolite clinoptilolite: new adjuvant in anticancer therapy.*

Natural zeolite clinoptilolite: new adjuvant in anticancer therapy.

Pavelic K, Hadzija M, Bedrica L, Pavelic J, Dikic I, Katic M, Kralj M,  
J Mol Med (Berl). 2001;78(12):708-20.

#### Abstract:

Natural silicate materials, including zeolite clinoptilolite, have been shown to exhibit diverse biological activities and have been used successfully as a vaccine adjuvant and for the treatment of diarrhea. We report a novel use of finely ground clinoptilolite as a potential adjuvant in anticancer therapy. Clinoptilolite treatment of mice and dog suffering from a variety of tumor types led to improvement in the overall health status, prolongation of life-span, and decrease in tumors size. Local application of clinoptilolite to skin cancers of dogs effectively reduced tumor formation and growth. In addition, toxicology studies on mice and rats demonstrated that the treatment does not have negative effects. In vitro tissue culture studies showed that finely ground clinoptilolite inhibits protein kinase (c-Akt), induces expression of p21WAF1/CIP1 and p27KIP1 tumor suppressor proteins, and blocks cell growth in several cancer cell lines. These data indicate that clinoptilolite treatment might affect cancer growth by attenuating survival signals and inducing tumor suppressor genes in treated cells.

#### *The effect of natural clinoptilolite on the serotonergic receptors in the brain of mice with mammary carcinoma.*

The effect of natural clinoptilolite on the serotonergic receptors in the brain of mice showed that there was a beneficial effect on those mice with mammary carcinoma.

Mück-Seler D, Pivac N.

Life Sci. 2003 Sep 5;73(16):2059-69.

#### Abstract:

The ex vivo effect of tribomechanically micronized zeolite (MZ) on the binding of 3H-8-OH-DPAT to 5-HT(1A) and 3H-5-HT to 5-HT(1B) receptors was investigated in the brain of nontumorous (control) and mammary carcinoma bearing female mice. During 14 and 28 days mice were fed with standard food, standard food supplemented with

25% of MZ, or standard food supplemented with 25% of non tribomechanically micronized zeolite (non-MZ). A reduced binding of 3H-8-OH-DPAT to 5-HT(1A) receptors in mammary carcinoma bearing mice was found when compared to control mice fed with standard food for 28 days, suggesting a time dependent alteration of 5-HT(1A) receptors in mammary carcinoma. The addition of MZ for 28 days in these mice abolished the decrease in 5-HT(1A) receptors binding, indicating a possible beneficial effect of MZ, at least on 5-HT(1A) receptors in mammary carcinoma bearing mice. The preliminary data show that MZ administered as a food supplement (25%) for 14 days induced a transient decrease in the binding of 3H-5-HT to brain 5-HT(1B) receptors only in control, but not in tumor-bearing mice, that disappeared after 28 days of MZ-supplemented food administration. The mechanism of the indirect action of MZ on the brain serotonergic receptors might be achieved by the alterations in the electrolytes balance, and/or by the regulation of the immune system.

*Dietary supplementation with the tribomechanically activated zeolite clinoptilolite in immunodeficiency: effects on the immune system.*

Dietary supplementation with an activated zeolite clinoptilolite in immunodeficiency: effects on the immune system which showed no adverse reactions to the treatment.

Ivkovic S, Deutsch U, Silberbach A, Walraph E, Mannel M.

*Adv Ther.* 2004 Mar-Apr;21(2):135-47.

**Abstract:**

Natural zeolites are crystalline aluminosilicates with unique adsorption, cation-exchange, and catalytic properties that have multiple uses in industry and agriculture. TMAZ, a natural zeolite clinoptilolite with enhanced physicochemical properties, is the basis of the dietary supplements Megamin and Lycopomin, which have demonstrated antioxidant activity in humans. The aim of this prospective, open, and controlled parallel-group study was to investigate the effects of supplementation with TMAZ on the cellular immune system in patients undergoing treatment for immunodeficiency disorder. A total of 61 patients were administered daily TMAZ doses of 1.2 g (Lycopomin) and 3.6 g (Megamin) for 6 to 8 weeks, during which the patients' primary medical therapy was continued unchanged. Blood and lymphocyte counts were performed at baseline and at the end of the study. Blood count parameters were not relevantly affected in either of the two treatment groups. Megamin administration resulted in significantly increased CD4+, CD19+, and HLA-DR+ lymphocyte counts and a significantly decreased CD56+ cell count. Lycopomin was associated with an increased CD3+ cell count and a decreased CD56+ lymphocyte count. No adverse reactions to the treatments were observed.

*A clinoptilolite effect on cell media and the consequent effects on tumor cells in vitro.*

Clinoptilolite effects the cellular micro-environment of cell media and consequently, has an effect on tumour cells in vitro.

Katic M, Bosnjak B, Gall-Troselj K, Dikic I, Pavelic K.

*Front Biosci.* 2006 May 1;11:1722-32.

**Abstract:**

Clinoptilolite is a nontoxic natural zeolite with properties of an ion-exchanger and adsorbent. Earlier studies showed that clinoptilolite could be an adjuvant in cancer therapy. The aim of this study was to define effects of clinoptilolite in cell media on cell viability and activity of key proteins regulating cell survival, cell division and stress response. The number of viable cells, DNA synthesis and activity of EGF-R, PKB/Akt and NF- $\kappa$ B was reduced, while apoptosis was increased in cells that were cultured in medium supplemented with clinoptilolite. These results might be due to adsorption of some serum components such as EGF to clinoptilolite. In treated medium without serum the predominant role of clinoptilolite is that of cation exchange, likely affecting calcium levels and calcium-dependent signalling pathways. These results are in line with other data that confirm enhanced apoptosis in cells incubated in treated medium. Together, data presented here demonstrate that clinoptilolite affects cellular microenvironment through mechanisms that are dependent on adsorptive and ion-exchange characteristics of the material.

*Natural zeolite clinoptilolite: new adjuvant in anticancer therapy.*

Mice and dogs suffering from cancer tumours had improved health and longer life span after clinoptilolite powder was used to treat their tumours. The treatment showed no negative effects.

Pavelic K, Hadzija M, Bedrica L, Pavelic J, Dikic I, Katic M, Kralj M, J Mol Med (Berl). 2001;78(12):708-20.

**Abstract:**

Natural silicate materials, including zeolite clinoptilolite, have been shown to exhibit diverse biological activities and have been used successfully as a vaccine adjuvant and for the treatment of diarrhea. We report a novel use of finely ground clinoptilolite as a potential adjuvant in anticancer therapy. Clinoptilolite treatment of mice and dog suffering from a variety of tumor types led to improvement in the overall health status, prolongation of life-span, and decrease in tumors size. Local application of clinoptilolite to skin cancers of dogs effectively reduced tumor formation and growth. In addition, toxicology studies on mice and rats demonstrated that the treatment does not have negative effects. In vitro tissue culture studies showed that finely ground clinoptilolite inhibits protein kinase (c-Akt), induces expression of p21WAF1/CIP1 and p27KIP1 tumor suppressor proteins, and blocks cell growth in several cancer cell lines. These data indicate that clinoptilolite treatment might affect cancer growth by attenuating survival signals and inducing tumor suppressor genes in treated cells.

*Pulmonary alveolar macrophage cytotoxicity investigation of irregular shape mineral dusts*

Investigation of cytotoxicity of six mineral dusts from 12 deposits. Results showed that clinoptilolite and one other being rounded in shape, had no AM cytotoxicity.

Dong F, Deng J, Pu X, John H.

**Abstract:**

In order to study the damage mechanism of mineral dusts on the pulmonary alveolar macrophages (AM), the changes of their death ratio, malondialdehyde (MDA) content and activities of lactate dehydrogenase (LDH) and superoxide dismutase (SOD) were measured. And the technique of cell culture in vitro was used to investigate the cytotoxicity of six mineral dusts (twelve crystal habits) from twelve mineral deposits. The results showed that wollstonite and clinoptilolite had no AM cytotoxicity while other fibrous and grainy mineral dusts could damage pulmonary AM in various degrees. The cytotoxicity of fibrous mineral dusts was greater than that of the grainy ones, and the cytotoxicity of dusts was positively correlated with the active OH<sup>-</sup> content in dusts, but not necessarily so with its SiO<sub>2</sub> content. The high pH values produced by dust was unfavorable for the cells survival and the dusts with a low bio-resistance were safe for cells. The content of variable valence elements in dusts could influence their cytotoxicity and the surface charge of dusts was not a stable factor on their toxicity. It indicates that the shape of mineral dusts is one of the factors affecting cytotoxicity, and that the cytotoxicity of mineral dusts mainly depends on their properties.

*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.*

Int J Toxicol. 2003;22 Suppl 1:37-102.

This interesting report investigates the possible dangers of zeolite. Of the zeolites it is said that they were not significantly toxic in oral acute or short term oral or parental studies in animals. Reference was made to inhalation toxicity. But these concerns relate only to large particle size, long, wide fibres which are not found in clinoptilolite. Elmore AR; Cosmetic Ingredient Review Expert Panel.

**Abstract:**

This report reviews the safety of Aluminum, Calcium, Lithium Magnesium, Lithium Magnesium Sodium, Magnesium Aluminum, Magnesium, Sodium Magnesium, and Zirconium Silicates, Magnesium Trisilicate, Attapulgite, Bentonite, Fuller's Earth, Hectorite, Kaolin, Montmorillonite, Pyrophyllite, and Zeolite as used in cosmetic formulations. The common aspect of all these claylike ingredients is that they contain silicon, oxygen, and one or more metals. Many silicates occur naturally and are mined; yet others are produced synthetically. Typical cosmetic uses of silicates include abrasive, opacifying agent, viscosity-increasing agent, anticaking agent emulsion stabilizer, binder, and suspending agent. Clay silicates (silicates containing water in their structure) primarily function as adsorbents, opacifiers, and viscosity-increasing agents. Pyrophyllite is also used as a colorant. The International Agency for Research on Cancer has ruled Attapulgite fibers >5 microm as possibly carcinogenic to humans, but fibers <5 microm were not classified as to their carcinogenicity to humans. Likewise, Clinoptilolite, Phillipsite, Mordenite, Nonfibrous Japanese Zeolite, and synthetic Zeolites were not classified as to

their carcinogenicity to humans. These ingredients are not significantly toxic in oral acute or short-term oral or parenteral toxicity studies in animals. Inhalation toxicity, however, is readily demonstrated in animals. Particle size, fibrogenicity, concentration, and mineral composition had the greatest effect on toxicity. Larger particle size and longer and wider fibers cause more adverse effects. Magnesium Aluminum Silicate was a weak primary skin irritant in rabbits and had no cumulative skin irritation in guinea pigs. No gross effects were reported in any of these studies. Sodium Magnesium Silicate had no primary skin irritation in rabbits and had no cumulative skin irritation in guinea pigs. Hectorite was nonirritating to the skin of rabbits in a Draize primary skin irritation study. Magnesium Aluminum Silicate and Sodium Magnesium Silicate caused minimal eye irritation in a Draize eye irritation test. Bentonite caused severe iritis after injection into the anterior chamber of the eyes of rabbits and when injected intralamellarly, widespread corneal infiltrates and retrocorneal membranes were recorded. In a primary eye irritation study in rabbits, Hectorite was moderately irritating without washing and practically nonirritating to the eye with a washout. Rats tolerated a single dose of Zeolite A without any adverse reaction in the eye. Calcium Silicate had no discernible effect on nidation or on maternal or fetal survival in rabbits. Magnesium Aluminum Silicate had neither a teratogenic nor adverse effects on the mouse fetus. Female rats receiving a 20% Kaolin diet exhibited maternal anemia but no significant reduction in birth weight of the pups was recorded. Type A Zeolite produced no adverse effects on the dam, embryo, or fetus in either rats or rabbits at any dose level. Clinoptilolite had no effect on female rat reproductive performance. These ingredients were not genotoxic in the Ames bacterial test system. In primary hepatocyte cultures, the addition of Attapulgite had no significant unscheduled DNA synthesis. Attapulgite did cause significant increases in unscheduled DNA synthesis in rat pleural mesothelial cells, but no significant increase in sister chromosome exchanges were seen. Zeolite particles (<10 microm) produced statistically significant increase in the percentage of aberrant metaphases in human peripheral blood lymphocytes and cells collected by peritoneal lavage from exposed mice. Topical application of Magnesium Aluminum Silicate to human skin daily for 1 week produced no adverse effects. Occupational exposure to mineral dusts has been studied extensively. Fibrosis and pneumoconiosis have been documented in workers involved in the mining and processing of Aluminum Silicate, Calcium Silicate, Zirconium Silicate, Fuller's Earth, Kaolin, Montmorillonite, Pyrophyllite, and Zeolite. The Cosmetic Ingredient Review (CIR). The Cosmetic Ingredient Review (CIR) Expert Panel concluded that the extensive pulmonary damage in humans was the result of direct occupational inhalation of the dusts and noted that lesions seen in animals were affected by particle size, fiber length, and concentration. The Panel considers that most of the formulations are not respirable and of the preparations that are respirable, the concentration of the ingredient is very low. Even so, the Panel considered that any spray containing these solids should be formulated to minimize their inhalation. With this admonition to the cosmetics industry, the CIR Expert Panel concluded that these ingredients are safe as currently used in cosmetic formulations. The Panel did note that the cosmetic ingredient, Talc, is a hydrated magnesium silicate. Because it has a unique crystalline structure that differs from ingredients addressed in this safety assessment, Talc is not included in this report.

*Study on carcinogenicity of clinoptilolite type zeolite in Wistar rats.*

Toxic Effect. Various materials were introduced into the lungs of rats and the lung tissue examined after 90, 180 and 360 days. Clinoptilolite was found to be inert while all the others showed cytotoxic effects to some degree. Pol J Occup Med Environ Health. 1993;6(1):27-34.

**Abstract**

The effects of samples of crystalline quartz, diatomaceous earth, mordenite and clinoptilolite were investigated in vitro (as concerns erythrocyte haemolysis and lactate dehydrogenase (LDH) release from peritoneal macrophages) and in vivo (on LDH, protein and phospholipids in rat bronchoalveolar lavage (BAL), and phospholipids in rat lung tissue). The respirable mineral samples were instilled intratracheally. Determinations in the BAL were carried out after 15, 60 and 180 days, and in the lung tissue after 90, 180 and 360 days. Quartz DC and quartz FQ induced acute, subacute and chronic inflammation and progressive fibrosis. However, due to the Al<sub>2</sub>O<sub>3</sub> contamination on the surface of the particles quartz FQ caused a delayed response in vivo. Diatomaceous earth produced acute/subacute inflammation that gradually became more moderate after 60 days. Clinoptilolite was inert, whereas the other zeolite sample, mordenite, was cytotoxic in vivo. The reason for this was presumably the needle and rod-shaped particles in the mordenite samples. The investigation revealed that different in vitro and in vivo methods can provide valuable data concerning the pulmonary toxicity of minerals.

*Distribution of dichlorvos in the rat and the effect of clinoptilolite on poisoning*

This study showed that clinoptilolite had no carcinogenic incidence of tumours in any tissues or organs and no carcinogenic activity in rats.

Tátrai E, Ungváry G.  
Vet Med (Praha). 1984 Nov;29(11):689-98.

**Abstract:**

In the first series of trials, the physiological values of tissue cholinesterases were determined in the male rats of the Wistar strain. In the second series of trials the rats were perorally intoxicated with dichlorvos at the doses of 200.0, 128.0, 81.9, 65.5 and 52.4 mg per kg live weight. The objective of the trials was to examine the distribution of dichlorvos in the body of a rat on the basis of tissue cholinesterase inhibition. A marked decrease in the level of tissue cholinesterases was recorded at all the dichlorvos doses. In the third series of trials the protective effect of clinoptilolite was verified; clinoptilolite as a sorbent of natural origin has been administered per os at the dose of 1.0 g per kg live weight just before the intoxication with dichlorvos. The results document a marked protective effect of clinoptilolite on most of the tissues studied.

*Preventive effect of zeolite in VX poisoning in rats*

Rats intoxicated with dichlorvos showed that clinoptilolite gave a marked protective effect on most tissues studied.  
Nistiár F, Hrusovský J, Mojzís J, Mizík P.  
Vet Med (Praha). 1994;39(8):443-9.

**Abstract:**

In the present paper the effect of zeolite tuff (61% clinoptilolite) was investigated on cholinesterase activity in brain, liver, spleen, femoral muscle, heart, stomach, duodenum, colon and erythrocytes in sewer-rats after peroral intoxication with VX substance (65.5 micrograms/kg). Fig. 1 shows the ChE activity in the tissues and erythrocyte in the animals of control group and in the group of animals after intoxication with VX substance. The highest activity in the control group was found in brain and duodenum. The enzyme activity in the femoral muscle had the lowest values. A significant decrease in the ChE activity ( $P < 0.001$  or  $P < 0.01$ ) occurred in all the investigated samples in the group of animals intoxicated with the VX substance. highest enzyme inhibition was observed in erythrocytes (97.9%), stomach (97.9%), brain (95.4%) and liver (94.7%) if compared with the control group. The relatively lowest inhibition was found out in duodenum and colon. In the group administered zeolite before intoxication (1.0 g/kg five minutes before intoxication) the ChE activity was significantly higher in almost all investigated samples than in the group without zeolite ( $P < 0.001$  or  $P < 0.01$ )-Fig. 2. The duodenum is an exception, in which the ChE activity in the zeolite group was lower than in the zeolite-free group ( $P < 0.001$ ), as well as the colon, in which there were no significant differences in the activity between the groups.(ABSTRACT TRUNCATED AT 250 WORDS)

*Effects of short-term supplementation of clinoptilolite in colostrum and milk on the concentration of some serum minerals in neonatal dairy calves.*

These rats were intoxicated by VX substance and those which had been given clinoptilolite showed significantly lowered ChE than the control group.

Mojzís J, Nistiár F, Kovác G, Mojzísová G.

Biol Trace Elem Res. 2008 Summer;123(1-3):116-23. doi: 10.1007/s12011-008-8114-y. Epub 2008 Mar 4.

**Abstract**

In recent years, the use of both natural and synthetic zeolites in animal nutrition has increased mainly to improve their performance, health, and to protect against mycotoxin intoxication. Thirty calves were used in the present study for the determination of some physiologic effects of clinoptilolite supplementation. The animals were divided equally into three groups (control, test 1, and test 2). The three groups of calves were homogeneous for parity of dams, sex, and month of birth. For group test 1, clinoptilolite in the concentration of 2% of each colostrum meal was added for 48 h, and for group test 2, clinoptilolite in the concentration of 2% was added to each colostrum and milk meal for 14 days. Blood samples were taken from all calves 12 h after birth and at the end of the first, second, third, fourth, fifth, and sixth weeks of life. Calcium (Ca), phosphorus (P), magnesium (Mg), iron (Fe), sodium (Na), and potassium (K) were determined in the serum. For statistical analysis of data, a repeated measures approach using analysis of variance (ANOVA) with mixed linear models was used. Clinoptilolite supplementation had significant effect on the concentrations of calcium, phosphorus, sodium, and iron. The concentrations of Fe were significantly higher in test group 2 than other trial groups ( $p < 0.05$ ). Calcium concentrations were significantly higher in serum of clinoptilolite-treated than control calves ( $p < 0.05$ ). The concentrations of phosphorus were significantly lower in test groups than control group ( $p < 0.05$ ). Sodium concentrations were significantly higher in clinoptilolite-supplemented groups than control calves ( $p < 0.05$ ). Potassium and magnesium concentrations were

not affected by clinoptilolite supplementation. Clinoptilolite supplementation could promote iron levels in serum and better hemopoiesis and prevent pathologic or physiologic drop of red blood cell (RBC) parameters in supplemented calves during a first few weeks of life. According to higher need and utilization of Ca in growing animals, clinoptilolite supplementation could increase available Ca. Based on the results of the present study and the importance of dietary phosphorus in many physiologic processes, the level of phosphorus in diet of neonatal dairy calves must be considered and adapted when clinoptilolite was supplemented. With an adequate supply of good quality drinking water, cattle can tolerate large quantities of dietary sodium chloride. Thus, it seems that significant increase in serum Na concentration during short-term supplementation of clinoptilolite in neonatal calves could be well tolerated without any adverse effects.

*The role of natural and synthetic zeolites as feed additives on the prevention and/or the treatment of certain farm animal diseases: A review*

There were no adverse effects of the short-term supplementation of clinoptilolite in colostrum and milk on the concentration of some serum minerals in neonatal dairy calves.

Mohri M, Seifi HA, Maleki M.

*Microporous and Mesoporous Materials* Volume 84, Issues 1–3, 15 September 2005, Pages 161–170

**Abstract**

The present review comments on the role of the use of zeolites as feed additives on the prevention and/or the treatment of certain farm animal diseases. Both natural and synthetic zeolites have been used in animal nutrition mainly to improve performance traits and, based on their fundamental physicochemical properties, they were also tested and found to be efficacious in the prevention of ammonia and heavy metal toxicities, poisonings as well as radioactive elements uptake and metabolic skeletal defects. During the last decade, their utilization as mycotoxin-binding adsorbents has been a topic of considerable interest and many published research data indicate their potential efficacy against different types of mycotoxins either as a primary material or after specific modifications related to their surface properties. Ingested zeolites are involved in many biochemical processes through ion exchange, adsorption and catalysis. Recent findings support their role in the prevention of certain metabolic diseases in dairy cows, as well as their shifting effect on nitrogen excretion from urine to faeces in monogastric animals, which results in lower aerial ammonia concentration in the confinement facilities. Moreover, new evidence provide insights into potential mechanisms involved in zeolites supporting effect on animals suffered from gastrointestinal disturbances, including intestinal parasite infections. All the proposed mechanisms of zeolites' effects are summarized in the present review and possible focus topics for further research in selected areas are suggested.

*Effect of feeding clinoptilolite (zeolite) on the performance of three strains of laying hens.*

In this paper there appears to be no safety or toxicity issues. This is a review of the role of natural and synthetic zeolites as feed additives in the prevention and/or the treatment of certain farm animal diseases. It comments that zeolites perform many beneficial mechanisms and new research suggests that zeolites have the potential to deliver positive effects in cases of gastro-intestinal occurrences and intestinal parasite infections.

D. Papaioannou, P.D. Katsoulos, N. Panousis and H. Karatzias

*Br Poult Sci.* 1997 May;38(2):220-2.

*Abstract*

1. One hundred and twenty 16-week-old single combed pullets of three strains were fed on a diet containing 135 protein/kg with or without 50 g clinoptilolite/kg in a trial with 20 hens per treatment. Sterile river sand replaced clinoptilolite in the control diet in order to keep the diets isoenergetic. The hens were individually caged in a naturally ventilated laying house and fed one of the two diets for ten 28-d periods.

2. Significant dietary effects of feeding clinoptilolite were observed with number of eggs laid per hen, shell thickness, efficiency of food utilisation and droppings moisture content. No significant dietary effects between treatments were observed with body weight, age at first egg, egg weight. Haugh units, food intake/hen and rate of amino acid absorption of radioactive lysine and methionine into the bloodstream. Significant differences between strains were observed with regard to all parameters except food intake/hen. There were no significant strain X clinoptilolite interactions.

*Protection by clinoptilolite or zeolite NaA against cadmium-induced anemia in growing swine.*

This South African study shows the effect of feeding clinoptilolite (zeolite) on the performance of three strains of laying hens. Although there were differences between the  
Olver MD.  
Proc Soc Exp Biol Med. 1983 Jul;173(3):332-7

**Abstract:**

Weanling Landrace X Yorkshire swine were fed a basal diet or a diet containing 3% clinoptilolite (a natural zeolite with or without 150 ppm CdCl<sub>2</sub> or 3% zeolite NaA (a synthetic zeolite) with or without 150 ppm CdCl<sub>2</sub> for 31 days. Hematocrit and hemoglobin were depressed significantly in animals fed Cd in the absence of zeolites, but not in their presence. Liver Cd concentration was increased dramatically by added dietary Cd but was significantly lower in animals fed clinoptilolite with Cd than in those fed Cd alone (11.4 vs 16.5 ppm). Liver Fe and Zn were decreased by dietary Cd; liver Fe was not affected significantly by clinoptilolite or zeolite NaA, but liver Zn was increased by zeolite NaA. Kidney dry matter, Zn, and Cd concentrations were increased by dietary Cd; neither clinoptilolite nor zeolite NaA affected kidney Cd concentration. Zeolite NaA increased kidney dry matter both in the presence and in the absence of dietary Cd. Plasma urea-N, K, Na, and Mg were unaffected by Cd or by either zeolite. The data illustrate the different effects of dietary clinoptilolite compared with zeolite NaA on blood plasma, liver, and kidney concentrations of minerals and provide evidence that both zeolites offer some protection against Cd-induced Fe-deficiency anemia; the magnitude of this protection and the effects of each zeolite on tissue concentrations of Cd and other materials need further quantification.

*In vivo reduction of radiocaesium with modified clinoptilolite in sheep*

Pigs fed clinoptilolite NaA were protected against cadmium-induced anemia and their liver minerals were unaffected.

Pond WG, Yen JT.

Vet Med (Praha). 1995 Aug;40(8):237-41

**Abstract:**

The efficiency of the sorbent prepared by immobilization of [Iron(II)hexacyanoferrate(II)] on clinoptilolite--marked as ZEOFe--in reduction of the radiocaesium Cs-137 has been in vivo investigated in sheep. It was found that an application of this modified clinoptilolite affected both primary and secondary resorption of Cs-137 also by interrupting the enteral cycle of radiocaesium in sheep. It was proved that ZEOFe accelerated approx. twice the excretion of Cs-137 from sheep's body. The whole effect resulted in 15 to 50 times lowering of the equilibrium concentration of radiocaesium in the case of constant intake of the contaminated feed and simultaneous application of 50 grams of ZEOFe daily. The actual reduction depends mainly on the way of administration. The reduction of Cs-137 by non-modified clinoptilolite--ZEO--has been investigated, too. More than 10x lower sorption efficiency has been observed in comparison with ZEOFe.

*Effects of long-term feeding dairy cows on a diet supplemented with clinoptilolite on certain serum trace elements*

Clinoptilolite given to sheep contaminated with radiocaesium showed marked reduction in the amount of contamination.

Jandl J, Novosad J.

Biol Trace Elem Res. 2005 Winter;108(1-3):137-45.

**Abstract:**

The objective of the experiment was to investigate the effect of clinoptilolite (a natural zeolite) supplementation in the ration of dairy cows on serum copper (Cu), zinc (Zn), and iron (Fe) concentrations. Fifty-two clinically healthy Holstein cows were randomly assigned to one of three groups according to their age and parity. The first group (group A) comprised 17 cows fed a ration supplemented with 1.25% clinoptilolite, the second group (group B) comprised also 17 cows was given a ration with 2.5% clinoptilolite, and the third group (group C, the control), comprised 18 cows fed the basal ration that did not contain any clinoptilolite. The experiment started when the cows entered the fourth week before the expected parturition and lasted until the end of lactation. All cows were fed the above concentrates during the entire experimental period. Blood samples were collected from each animal at the starting day of the experiment, at the day of calving, and at monthly intervals thereafter. All samples were tested for serum Cu, Zn, and Fe concentrations. The results showed that the 1.25 and 2.5% supplementation of clinoptilolite did not have any adverse effects on serum concentrations of Cu, Zn, and Fe.



Effects of long-term feeding of a diet supplemented with clinoptilolite to dairy cows on the incidence of ketosis, milk yield and liver function.

A long-term study of feeding a diet supplemented with clinoptilolite to dairy cows showed no adverse effects from week 4 until the end of lactation and the tests conclusion.

Katsoulos PD, Roubies N, Panousis N, Karatzias H.

Vet Rec. 2006 Sep 23;159(13):415-8.

*Abstract;*

Fifty-two clinically healthy Holstein cows were randomly assigned to one of three groups according to their age and parity. The first group (A) consisted of 17 cows that were fed a concentrate ration supplemented with 1.25 per cent clinoptilolite, the second group (B) consisted of 17 cows fed a ration supplemented with 2.5 per cent clinoptilolite, and the third group (C) consisted of 18 cows, which were fed the basal ration containing no clinoptilolite. The rations were fed from four weeks before the cows' expected parturition dates until the beginning of the next dry period. Blood samples were collected from each animal at the start of the experiment, on the day of calving and then monthly, and analysed for serum glucose, ketone bodies, liver enzymes, blood urea nitrogen (BUN) and total proteins. The milk yield of each cow was recorded monthly. The cows in group B had significantly fewer cases of clinical ketosis during the first month after calving and a higher total milk yield. Feeding the cows with clinoptilolite for a long period had no apparent adverse effects on their liver function, and did not significantly affect the concentrations of glucose, ketone bodies, BUN and total proteins in their serum.

Effect of clinoptilolite on performance of Japanese quail (*Coturnix coturnix japonica*) during experimental aflatoxicosis.

Effects of long-term feeding of a diet supplemented with clinoptilolite to dairy cows on the incidence of ketosis, milk yield and liver function.

Katsoulos PD, Panousis N, Roubies N, Christaki E, Arsenos G

Br Poult Sci. 1999 Sep;40(4):495-500.

*Abstract:*

Clinoptilolite (CLI, a natural zeolite), incorporated into the diet at 50 g/kg, was evaluated for its ability to reduce the deleterious effects of 2.0 mg total aflatoxin (AF; 83.06% AFB<sub>1</sub>, 12.98% AFB<sub>2</sub>, 2.84% AFG<sub>1</sub> and 1.12% AFG<sub>2</sub>)/kg diet on growing Japanese quail chicks from 10 to 45 d of age. A total of 40 Japanese quail chicks were divided in 4 treatment groups (control, AF, CLI, AF plus CLI) each consisting of 10 chicks. The performance of the birds was evaluated. The AF treatment significantly decreased food consumption and body weight gain from the 3rd week onwards. The adverse effect of AF on food conversion ratio was also significant from week 4 of the experiment. The addition of CLI to an AF-containing diet significantly reduced the deleterious effects of AF on food consumption, body weight gain and food conversion ratio. Food consumption was reduced by 14% in quail chicks consuming the AF diet without CLI, but by only 6% for quail chicks consuming the AF plus CLI diet. Similarly, overall body weight gain was reduced by 27% in birds consuming the AF diet without CLI, but by only 8% for birds consuming the AF plus CLI diet. The addition of CLI to the AF-free diet significantly decreased food consumption and body weight gain during week 4, but these parameters were similar to the controls in week 5. No mortality was observed in any of the groups. These results suggest that CLI effectively diminished the detrimental effects of AF on the variables investigated in this study.

Physiological and toxicological responses in rats fed aflatoxin-contaminated diet with or without sorbent materials

This study showed that forty Japanese quail chicks given clinoptilolite in their food reduced the detrimental effects of aflatoxicosis. At the end of the study there were no mortalities in any of the study groups.

Parlat SS, Yildiz AO, Oguz H.

Animal Feed Science and Technology. Volume 97, Issues 3–4, 3 June 2002, Pages 209–219

*Abstract:*

Hydrated sodium calcium aluminosilicate (HSCAS), a sorbent compound obtained from natural zeolite, has

demonstrated an ability to sorb aflatoxins (AFs) with a high affinity. Addition of this compound to feedstuffs contaminated with AFs has shown a protective effect against the development of aflatoxicosis in farm animals. The objective of the present study was to compare the efficiency of HSCAS and local montmorillonite silicate in respect of the protection against aflatoxicosis in the rat as a sensitive animal model. AF treatment (2.5 mg kg<sup>-1</sup> diet) significantly reduced blood hemoglobin, erythrocytes, leukocytes, cholesterol, triglycerides, cholinesterase, total protein, albumin, zinc and copper concentrations. While it significantly increased creatinine, bilirubin, urea nitrogen, alkaline phosphatase and transaminases concentrations. In addition, AF administration induced degenerative changes in the hepatic and renal tissues. The results indicated that addition of HSCAS or montmorillonite to the AF-contaminated diet at a level of 5 g kg<sup>-1</sup> resulted in a significant improvement in the hematological and biochemical parameters, mineral retention and histological picture of both liver and kidneys.

It is concluded that the deleterious effects of AF could be overcome or, at least, diminished by sorbents. Moreover sorbents by themselves had no toxic effects.

*Effects of zeolites on cultures of marine micro-algae: A brief review.*

In a trial of rats fed a contaminated diet containing aflatoxin and sorbent materials (natural zeolites) it was determined that the sorbents by themselves had no toxic effects.

M. A. Abdel-Wahhab, , a, S. A. Nadab and F. A. Khalil  
*Environ Sci Pollut Res Int.* 2006 Oct;13(6):414-7.

Abstract:

**GOAL, SCOPE AND BACKGROUND:**

The cation-exchange capacity of zeolites is well known and has been increasingly explored in different fields with both economic and environmental successes. In aquatic medium with low salinity, zeolites have found multiple applications. However, a review of the literature on the applications of zeolites in salt waters found relatively few articles, including some recently published papers. The purpose of this review is to present the state-of-the-art or applications of using zeolites for amending the trace elemental contents of salt water as well as the implications of this property for promoting marine micro-algal growth.

**MAIN FEATURES:**

This paper deals with the following features: Sorption capacity of zeolites including 1. application of zeolites in saltwater, 2. the role of silicon and zeolites on cultures of micro-algae, and 3. the role of organically chelated trace metals.

**RESULTS:**

The following competing factors have been identified as effects of zeolites on algal growth in salt water: (i) ammonia decrease: growth inhibition reduced; (ii) macro-nutrients increase, mainly silicon: stimulation of silicon-dependent algae; (iii) trace metals increase (desorption from zeolites) or decrease (adsorption): inhibition or stimulation, depending on the nature of the element and its concentration; and, (iv) changes in the chelating organics exudation: inhibition or stimulation of growth, depending on the (a) nature of the complexed element; (b) bioavailability of the complex; and (c) concentration of the elements simultaneously present in inorganic forms.

**DISCUSSION:**

Zeolites have been capable of stimulating the growth of the silicon-demanding marine micro-algae, like diatoms, mainly because they can act as a silicon buffer in seawater. Zeolites can also influence the yield of non-silicon-demanding algae, because the changes they can cause (liberation and adsorption of trace elements) in the composition of the medium.

**CONCLUSIONS:**

Zeolites have been capable of stimulating the growth of the marine micro-algae. However, the extent of ion exchange between zeolite and seawater, which conditions the effects, will depend on several factors: (1) initial metal concentration in seawater; (2) levels of trace metals in the zeolites (contaminants); (3) characteristics of the zeolites in terms of both ion-exchange capacity and specific affinities for the different cations; (4) quantity of zeolite per litre of solution; (5) pH and (6) response of the organism in terms of liberation of organic ligands.

### **RECOMMENDATIONS AND PERSPECTIVES:**

#### **RECOMMENDATIONS:**

Therefore, a previous investigation in each particular case is recommended, in order to select the zeolitic characteristics and concentrations that will maximize the algal yield.

#### **PERSPECTIVES:**

Stimulation of phytoplankton growth can be economically relevant since phytoplankton constitutes the basis of the marine food webs and is required in fish farming nurseries in the marine aquaculture industry. Zeolites are cheap and only small amounts (few milligrams per liter of culture) are required and the addition of some micro-nutrients may be omitted. Therefore, the inclusion of zeolites in algal cultures in aquaculture may have economic advantages.

#### *The effect of zeolite on the toxicity of lead to fungi.*

Effects of zeolites on cultures of marine micro-algae: The study showed that the zeolite stimulated the growth of phytoplankton, the basis of all marine food webs, and was non-toxic to the algae. Fachini A, Vasconcelos MT.

Environ Pollut. 1988;49(3):235-41.

#### Abstract:

In order to determine whether clinoptilolite, a naturally occurring zeolite, had any ameliorative effect on lead (Pb) toxicity to fungi, a series of growth experiments were performed. Three fungi, *Aspergillus niger*, *Botrytis cinerea*, and *Fusarium culmorum*, were grown on appropriately amended solid agar media, and their linear extension rates were determined. *B. cinerea* was 25% inhibited, as compared to a control, at 100 mg dm<sup>-3</sup> Pb, and completely inhibited at 1000 mg dm<sup>-3</sup> Pb. *F. culmorum* was completely inhibited, and *A. niger* 97% inhibited at 1000 mg dm<sup>-3</sup> Pb. The addition of 3% clinoptilolite partially removed this inhibition in the case of *A. niger* and *B. cinerea* and almost completely removed it for *F. culmorum*. At a constant 500 mg dm<sup>-3</sup> Pb, increasing concentrations of clinoptilolite increased the linear extension rate of *F. culmorum* and *B. cinerea*, close to the rates achieved by the untreated controls. *A. niger* was not inhibited markedly at this Pb concentration. The evidence suggests that the Pb is adsorbed by the clinoptilolite which reduces the availability, and hence toxicity, of the metal to the fungi.

#### *In vitro evaluation of the use of zeolites as biomaterials: effects on simulated body fluid and two types of cells.*

The effect of clinoptilolite zeolite on the removal of lead toxicity from fungi without being toxic to the fungi itself. Harris JA, Birch P.

J Mater Sci Mater Med. 2007 Aug;18(8):1557-62. Epub 2007 Apr 17.

#### Abstract:

Various zeolites were kept in simulated body fluid (SBF) for different periods of time. Possible changes that may occur in the crystalline structures of zeolites and the chemical composition of SBF were determined by various analysis techniques after this treatment. The possible effects of two different zeolites on the morphology and viability of chronic myelogenous leukemia and swiss albino fibroblast culture cells were also investigated. It was determined that when different types of zeolites were kept in the SBF for up to 14 days, their crystal structures were not affected. Observable amounts of Si were detected in the SBF samples after their treatment with all the zeolites investigated. Another variation in the chemical composition of SBF, worth to mention, was the increase of

about 10% in its K content after the treatment carried out by using clinoptilolite. The zeolites KA and silicalite, which allowed the lowest and highest amount of silicon transfer into the SBF, respectively, were observed not to have any significant biological effect on the two different cell generations investigated under the conditions used in this study.

*De-aluminated zeolite Y as a tool to study endocytosis, a delivery system revealing differences between human peripheral dendritic cells.*

When two zeolites were placed in simulated body fluids ('SBF') for a period of 14 days no biological effects were observed except a small transfer of potassium.

Ceyhan T, Tatlier M, Akçakaya H.

Scand J Immunol. 2007 Jul;66(1):52-61.

**Abstract:**

We report the use of nanometre-sized zeolite particles as a novel approach to follow the endosomal acidification and proteolysis inside a viable cell. The method was verified by using human peripheral monocytes, a well known endocytosing cell population. Zeolite particles were subsequently used to investigate the endocytosing mechanisms of human peripheral dendritic cells (DC). Probes detecting pH neutral and acidic endosomes were adsorbed to de-aluminated zeolite Y, and used to detect endocytosis in immature human peripheral blood DC. Both the myeloid (mDC) and the plasmacytoid (pDC) dendritic cell subsets had an endocytosing capacity comparable with peripheral blood monocytes. However, the majority of both subsets of DC retained their endosomes at a neutral pH during the first hours after endocytosis and only a small number of the mDC showed any formation of acidic endosomes. Proteolytic degradation of endocytosed proteins was detected using self-quenched DQ-ovalbumin adsorbed to zeolite particles. Interestingly, a clear difference in proteolytic degradation of endocytosed ovalbumin was observed between the two subsets of DC. The mDC showed an efficient degradation of ovalbumin, while the pDC population displayed no or only minor proteolytic degradation. In conclusion, zeolite particles provide a useful tool to study the endocytosing mechanisms, and an efficient carrier of bio-molecules into the endosomal pathways of viable cells.

*Comparative efficacy of granular and bagged formulations of the hemostatic agent QuikClot.*

A study in Sweden using de-aluminated zeolite as a method to study endocytosis inside viable human peripheral dendritic cells provided an efficient carrier of bi-molecules into endosomal pathways of viable cells without affecting the cells themselves.

Andersson LI, Eriksson H.

J Trauma. 2007 Oct;63(4):775-82.

**Abstract:**

**BACKGROUND:**

QuikClot is a zeolite-based dressing approved and deployed by military for the arrest of severe combat-induced hemorrhage. A novel formulation (bagged QuikClot [ACS]) of the original granular QuikClot (QC) has been proposed to facilitate the application of the hemostatic dressings under battlefield conditions. This study compares the hemostatic efficacy of ACS and QC in controlling blood loss and improving survival in a swine model of uncontrolled hemorrhage induced by complex groin injury.

**METHODS:**

After transection of the femoral vasculature, anesthetized Yorkshire pigs (n = 32) were hemorrhaged for 3 minutes and randomized into four groups: no treatment (NONE) or application of standard dressing (SD), QC, or ACS. At 15 minutes, resuscitation was initiated by infusion of 500 mL Hextend during a span of 30 minutes. Vital signs were continuously recorded throughout the 4-hour experimental period. In addition, blood loss and temperature at the dressing and tissue interface were continuously recorded.

**RESULTS:**

After 3 minutes, average blood loss was 44.7% +/- 11.9% estimated blood volume (EBV) for all animals (34.1 +/- 3.2 kg). Posttreatment blood loss was significantly higher ( $p < 0.01$ ) for NONE- and SD-treated animals (31.5% + 21.8% and 22.3% +/- 12.6% EBV, respectively) as compared with animals treated with QC and ACS (7.4% +/- 7.1% and 10.3% +/- 6.9%, respectively). All NONE animals died at approximately 60 minutes. Times until death were slightly greater for animals treated with SD (96.8 minutes) and significantly greater for animals treated with QC (188 minutes) and ACS (194 minutes). Overall survival to 4 hours for SD (1 of 8, 12.5%) was significantly lower ( $p < 0.02$ ) than for QC (6 of 8, 75%) and for ACS (6 of 8, 75%) treatments. Elevated temperatures at the dressing and tissue interface were seen in animals treated with QC and ACS (average at 8 minutes was 58.1 +/- 4.5 degrees C and 58.2 +/- 5.3 degrees C, respectively) compared with SD treated animals (38.8 +/- 2.7 degrees C). Histologic examination revealed more edema in muscular tissue of animals treated with ACS as compared with QC-treated animals.

### **CONCLUSIONS:**

ACS was as efficacious as original granular QC in inducing hemostasis and improving survival as compared with the efficacy of SD. Easier and more rapid application and complete removal of ACS may offer a distinct advantage in battlefield resuscitation efforts to enhance a clean wound site and eventual surgical repair.

#### Comparative efficacy of granular and bagged formulations of the hemostatic agent QuikClot.

QuikClot is a wound dressing approved and deployed by the United States Military to stop bleeding from severe combat wounds.

Arnaud F, Tomori T, Saito R, McKeague A, Prusaczyk WK, McCarron RM.

J Trauma. 2007 Oct;63(4):775-82.

Abstract:

### **BACKGROUND:**

QuikClot is a zeolite-based dressing approved and deployed by military for the arrest of severe combat-induced hemorrhage. A novel formulation (bagged QuikClot [ACS]) of the original granular QuikClot (QC) has been proposed to facilitate the application of the hemostatic dressings under battlefield conditions. This study compares the hemostatic efficacy of ACS and QC in controlling blood loss and improving survival in a swine model of uncontrolled hemorrhage induced by complex groin injury.

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ACS was as efficacious as original granular QC in inducing hemostasis and improving survival as compared with the efficacy of SD. Easier and more rapid application and complete removal of ACS may offer a distinct advantage in battlefield resuscitation efforts to enhance a clean wound site and eventual surgical repair.

*A case series describing thermal injury resulting from zeolite use for hemorrhage control in combat operations.*  
A case series describing thermal injury resulting from zeolite use for haemorrhage control in combat operations.  
McManus J, Hurtado T, Pusateri A, Knoop KJ.  
Prehosp Emerg Care. 2007 Jan-Mar;11(1):67-71.

Four cases are presented to illustrate cutaneous burns sustained with the use of zeolite in the treatment of major hemorrhage secondary to combat wounds. Zeolite, a microporous crystalline aluminosilicate granular hemostatic agent, can cause secondary thermal injuries through an exothermic reaction that is likely related to the absorption of free fluid at the hemorrhage site. Understanding of this process may help both military and civilian EMS personnel avoid or minimize secondary thermal injury while still benefiting from zeolite's hemostatic capabilities.

*Pharmacokinetic study of zeolite A, sodium aluminosilicate, magnesium silicate, and aluminum hydroxide in dogs*  
Pharmacokinetic study of zeolite A, sodium aluminosilicate, magnesium silicate, and aluminium hydroxide in dogs  
Cefali EA, Nolan JC, McConnell WR, Walters DL.  
Pharm Res. 1995 Feb;12(2):270-4.

#### **Abstract:**

Zeolite A is a synthetic zeolite which may have therapeutic utility in osteoporotic individuals because of its ability to stimulate bone formation. A study of Zeolite A (30 mg/kg), sodium aluminosilicate (16 mg/kg), magnesium trisilicate (20 mg/kg), and aluminum hydroxide (675 mg) was designed in beagle dogs. The purpose of this study was to compare the oral bioavailability of silicon and aluminum from Zeolite A, sodium aluminosilicate, magnesium trisilicate, and aluminum hydroxide in dogs. Twelve female dogs received each compound as a single dose separated by one week in a randomized, 4-way, crossover design. Plasma samples were drawn at time 0 and for 24 hours after dosing. The concentrations of silicon and aluminum were determined by graphite furnace atomic absorption. The mean plasma silicon AUC values (+/- S.D.) were 9.5 +/- 4.5, 7.7 +/- 1.6, 8.8 +/- 3.0, 6.1 +/- 1.9 mg.hr/L and the mean plasma silicon Cmax values (+/- S.D.) were 1.07 +/- 1.06, 0.67 +/- 0.27, 0.75 +/- 0.31, 0.44 +/- 0.17 mg/L for Zeolite A, sodium aluminosilicate, magnesium trisilicate, and aluminum hydroxide respectively. Although mean silicon AUC and Cmax values were elevated when compared to baseline after administration of the silicon containing compounds, only the AUC from Zeolite A reached statistical significance (p = 0.041). The mean plasma silicon Tmax values (+/- S.D.) were 7.9 +/- 6.4, 5.8 +/- 4.6, 6.9 +/- 6.3 and 8.5 +/- 3.4 hrs for Zeolite A, sodium aluminosilicate, magnesium trisilicate and aluminum Hydroxide respectively.(ABSTRACT TRUNCATED AT 250 WORDS)