Anima Sanum™(Activated Micronized zeolite Clinoptilolite) as Calves and Ruminants Feed Additive

1. Introduction

Anima Sanum™ additive is natural, non-toxic, environmental-friend substance manufactured from a natural zeolite Clinoptilolite. This additiveis consisted of micronized hydrated Aluminum silicate with other essential trace elements such as Fe++, Mg++ and Mn++.

1.1 Historical review for Natural Zeolite

In 1756, a Swedish mineralogist called Freiherr Axel Fredrick Cronstedt, collected a suite of well-formed crystals from the Svappavari Copper Mine, Lappmark, Sweden (Mumpton, 1978). Because the mineral exhibited intumescence when heated in blowpipe flame, he called the mineral "Zeolite" which means in Greek "to boil" and "stone" (Breck, 1974). Geologists and mineralogists soon recognized Zeolite as an abundant mineral in basalt cavities. Later on, more than 1000 occurrences of Zeolite minerals were reported from sedimentary rocks of volcanic origin in more than forty countries.
Today, efforts are being made to utilize natural Zeolites as well as to develop new applications that take advantage of the low mining costs of natural Zeolites (Mumpton, 1978).

1.2 Definitions and Chemical Framework

Zeolite is an alumino-silicate, whose framework structure of (Si, Al) O_4 tetrahedral contains pores filled with water molecules and exchangeable cations. Zeolite boils at about 200 °C, giving off water, which is readily readsorbed at room temperature (Gottardi, 1978). Bubbles of fluids in the parent magma form zeolites, and the zeolite crystals grow as a result of the chemical action of these fluids on the magma (Barrer, 1978).
Zeolites have a rigid 3-dimentional crystalline structure consisting of a network of interconnected tunnels and cages. The pore and channel sizes are nearly uniform allowing the crystal to host molecules and positively charged ions of appropriate molecular size that fit into the pores and act as a "molecular sieve" (Jabr, 2004).
Zeolites are classified, based on the crystal structure, into groups having the same units but which are linked to form different frameworks (Gottardi, 1978). The bulk composition of Zeolites tend to correlate with those of the parent rock; more aluminous Zeolites are associated with rocks deficient in silica and more siliceous Zeolite with rocks high in silica (Barrer, 1978). Zeolite is stable under normal conditions and up to 200 °C when it begins to boil. It can undergo extraordinary high temperatures before being melted at 1000 °C. Zeolite doesn't evaporate and is not soluble in water.

1.3 Applications of Zeolite in Animal Husbandry

The application of Zeolite overseas in animal husbandry has resulted in increasing feed efficiency, improving production rates and rumen microbial activity, and decreasing mortality rates. Zeolite was effective in eliminating poisonous effects of toxicants (Aflatoxins and Acidosis), therefore, reducing need for antibiotics and veterinary medicines. Moreover, it was approved that Zeolite has the potential to prevent ammonia related health problems and extending bedding life by keeping bedding dryer for animals due to its ability for absorbing ammonia and related odorous gases and trapping them into its crystalline structure (Mumpton, 1978).

The natural Zeolite structure binds mycotoxins to its surface and ionically buffers the digestive tract. Due to the surface cation exchange capacity (CEC), the Zeolite surface is polar and attracts the complex and polar mycotoxins molecules. The internal CEC binds positively charged ions such as the ammonium cation. When excess ammonia builds up in the digestive tract, Zeolite exchanges ion, thereby reducing the toxic effects of excess ammonia.

EU approves zeolite for usage in the swine and poultry industry as Mycotoxins binder. (70/524/EEC)

FDA approves zeolite for usage in animal feeds as an anti-caking agent. (CFR 582-2727)

Why Anima Sanum™ is different?

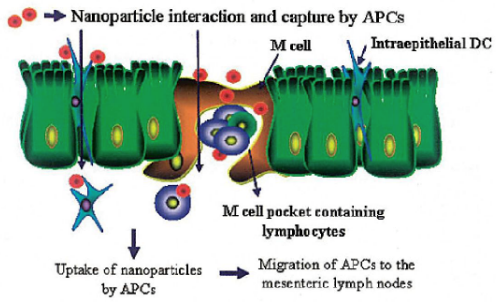
Milled vs. Micronized Zeolite

New physical properties, bioavailability and bio-efficacy of solid substances are often intrinsically related to the primary particle size and proportion of amorphous surface area. The natural zeolite, crystal structure (crystallite) and framework limit the particle size. Too large of a particle size distribution profile limits the bioavailability and detox properties. Too small particles (e.g., in the sub-micron and Nano-range) reduces adsorption and cation exchange capacity (CEC), because the crystal structure, will be when the particles are ground or processed to particle sizes smaller than the basic, crystallite. Therefore, to achieve maximum bio-function, bio-effect, it is a trade-off, between finer particle size and effectiveness per mg dose of the zeolite. As the particles decrease in medium size (diameter) from macro particles to micro particles, then smaller to colloidal and the nanoparticle range the surface area (S) decreases as a (A^2) square function and volume (V^3) as cubic function and the S/V Ratio becomes larger.

Thus, many attempts have been conducted to obtain good bioavailability achieved by creating amorphous product. Particle size reduction by top-down processing i.e. milling is one of various strategies for improving solubility and reactive characteristics of poorly water-soluble ingredients. When zeolite rocks are “milled”, they are grinded to powder. This is normally takes place at the mine and it the cheaper way to create powder. The problem with the milling process is that it crushes the zeolite cage structure rendering the zeolite un-absorbable in the body and largely less effective. However, certain particular dynamic micronization has been recognized as one of the most effective way to improve dissolution behavior.

More recently Clinoptilolite nutrient supplement, nutraceuticals and heavy metals, detox products have been introduced into the market place for humans. However, micronized product has the advantage for metals detox, because of the micronized particle size range, micro-crystal structure and ultrahigh surface area, which translates to: a) more efficient adsorption per gm of mineral; and b) higher CEC (meq/gm) loading cations (e.g., As, Hg, Pb, Cd, Cu, Zn, etc.), nutritional and bio-medical application.

Micronizing of clinoptilolite increases specific, amorphous and mesoporous surface area, enhancing adsorptive and detoxifying properties [*Lelas, Cepanec, WO/2009/133413, Formulation based on micronized clinoptilolite as a therapeutic agent for removal of toxins, bacteria and viruses from organism*]. It is possible to enhance the NH_4^+ retention capacity of natural clinoptilolite just by decreasing particle size without incorporating any further exchangeable cations within the framework of zeolite [(21)]. Micronized zeolite Clinoptilolite (MZC) particles below 5 microns can be entrapped within intestinal payer's patches via micro fold cells and exhibit lymphocyte response [(21,22)], followed by cascade of superantigens immunization signals.



These effects (immune modulation) were confirmed in both animal and human studies [(22,23)]. In mice, due to immune stimulation, MZC exhibited anti metastatic effect [(23)]. Finally, MZC exhibited excellent protective and regenerative effect on liver [(24-27)] and in patients with burn wound trauma [(28)].

2.0 Applications of ANIMA SANUM™

Due to its unique micronization technology and improvement of Zeolite-based superb characteristics and cost saving features, **ANIMA SANUM**™is widely used by producers of broilers, commercial eggs, beef, dairy cattle and sheep.

Major applications of **ANIMA SANUM**™ in feedlot and stock feed can be listed into the following categories:

Cost Effective- Feed Additive Increased Feed Efficiency

- Improved Rumen Microbial Activity.
- Improved Immune Stimulation in Calves
- Toxicity Prevention (Aflatoxins andAcidosis).

Feedlot Manures and Odor Control

- Drier, less odorous feedlot wastes.
- Manure Richer in Nutrients.
- Reduced Necessity for Antibiotics

2.1 Cost Effective Feed Additive

2.1.1 Increased Feed Efficiency

Positive effect of combined feed with zeolite on digestibility of nutrients; balance of nitrogen, calcium and phosphorous, and average daily increase of weight of heifers has been noticed (Kirolove et al., 1995). Kado et al. (1969) found that adding zeolite to the feed of young

calves, improved growth rate of young calves by stimulating appetite and decreased incidence of diarrhea and soft feces, and increased feed efficiency.

2.1.2 Improved Rumen Microbial Activity

Ruminant animals constantly deal with the metabolic effects of ammonia, which is a product of protein breakdown in the rumen. Maximizing the conversion of ammonia into microbial protein, especially fiber digestion bacteria, provides an economic advantage to farmers. In addition, the non-protein nitrogen and readily degradable protein sources which result in large releases of ammonia in the rumen are very inexpensive sources of protein for ruminant animals. As a result, the use of **ANIMA SANUMTM**^{TM} is economically beneficial.

Furthermore, it was found by (White and Ohlrogge, 1974) that up to 15% of ammonia in the rumen could be taken up by zeolite. Thus the gradual release of ammonia allowed rumen microorganisms to synthesize cellular protein, which lead to decrease the loss of nitrogen in the rumen.

2.1.3 Toxicity Prevention

Zeolite can effectively binds aflatoxins and protects livestock from their ill effects. This can be very important in farm-based feedlots where grain storage may not be perfect.

Moreover, zeolite is commonly used in dairy cow rations to reduce the impact of mycotoxins in the feed, and its also effective for ameliorating the negative impact of mold produced toxins in animal feeds.

Furthermore, the cation exchange capacity (CEC) of zeolite enables effective rumen buffering (pH) which can reduce the acidosis (grain poisoning) effects of excessive grain intake especially during the introductory phase of feedlot rations.

2.2 Feedlot Manures and Odor Control

One of the major by-products of the feedlot industry is animal waste in the form of manures, which can attract flies and produce odors.

2.2.1 Drier, less odorous feedlot wastes

ANIMA SANUM^{TM}has a twofold effect on reducing odor and stall wetness by trapping moisture and ammonia gas into its crystalline structure. By being porous it:

- Absorbs gases (including Ammonia and Hydrogen Sulphide) as they are evolved from urine and manure breakdown in the pens.
- Absorbs water that results in a drier manure pad. Industry research shows that odor increases with humidity and by maintaining a drier pad, and then feedlot odor is significantly reduced.

2.2.2 Manure richer in nutrient

The zeolite containing manure is easier to dispose of since it is drier, richer in nutrients (N, P, K and trace elements) and lower in sodium. Additionally, the nutrients in zeolite containing manure are more available to plants and result in increased plant growth by increasing water retention, holding nutrients in the root growth zone, increasing the cation exchange

capacity (CEC) and pH buffering of the soil, and enhanced infiltration and aeration of soil. Therefore, The farm-feedlot can obtain these benefits as a byproduct of the feedlot operation.

Another striking benefit could be gained due to the additive of zeolite into the compost or dry stacked manure after it is turned or after the addition of a new layer of manure; adding a thin layer of **TERRA SANUM^{TM}**in the area of the barn receiving the fresh manure will get the following benefits:

- Converts organically bound nitrogen that is not plant accessible to ammonium hydroxide, ammonium nitrate, and ammonia that are plant accessible.
- Reduces or eliminates the odor.
- Dries the manure.
- Reduces the flies.
- Kills the pathogens and weed seeds.

2.2.3 Reduced Necessity for Antibiotics

The use of **ANIMA SANUMTMTM** in animal feed increases gain and production and reduces or eliminates the need for antibiotics. In Europe where zeolite is commonly fed, antibiotics are not used.

Activated Zeolite - Animal Feed Additive

Summary of Scientific Literature

What Are Zeolites?

- Zeolites have a high attraction for water and many positively charged ions (K+, NH4+, Ca2+, Na+ and Mg2+) that can be reversibly bound or released depending on the surrounding conditions (Hay 1978). Zeolites are beneficial feed additives for ruminants because of their high affinity for nutritionally vital species.

- Through their ion-exchange selectivity, zeolite minerals may act as sinks for the adsorption of excess rumen ammonia after feeding and gradually release it as the zeolites are regenerated to their natural state by cations from the saliva. Zeolites provide a more stable rumen environment with respect to N availability, that is beneficial to both rumen microbial fermentation and animal performance (Sweeney T. et al. 1983).

- Zeolites have a quantitative effect on digestion by influencing rumen retention time (alteration of rumen turnover of fluid and/or particulate phases of digestion.

- Optimum performance.

- Additionally zeolite can improve the physical properties of the feed by increasing flowability, reducing moisture levels, or as an anti-caking agent.

Effect of Feeding Clinoptilolite to Cows

Bergero D., (1997) Universita di Torino, Via Nizza, Italy

- Beneficial effects on the ammonium levels in rumen fluid and blood serum levels.
- Zeolites and ammonium play important roles in nitrogen and protein supply in the rumen. The ammonium level in rumen fluid is an indicator of rumen nitrogenmetabolism with particular reference to ruminal protein degradation.
- Using urea instead of protein in well-balanced diets can make reduction in the cost of cow diets. Ruminal bacteria to build body can effectively use urea protein (that is afterwards digested and used by the cow as a source of amino acids). A diet with a high percentage of soluble nitrogen can release large amounts of ammonium in the rumen fluid, especially in the ammonium peak, during the initialpost-prandial time.
- The use of urea or other sources of non-protein nitrogen (NPN) in dairy cows, such asthe use of diets containing high percentages of soluble protein, could cause anincrease in rumen pH and ammonium concentration and a subsequent increase in theconcentration of ammonium in blood serum. Risks of toxicity can be linked to theincrease in both the pH of the rumen and the ammonium levels in blood serum.
- Natural Zeolites have the ability retain excess (adsorb) ammonium in the rumen andto subsequently release this cation when the rumen concentration lowers. The zeolitelowers the risk of toxicity by preventing both a pH increase and an increase ofammonium in the blood serum. The ammonium level is maintained constant(buffered) with beneficial effects on the metabolism of ruminal bacteria.
- Urea level in milk decreases at 5 hours post-prandial time.
- Quote Mumpton and Fisherman (1977): 1% zeolite added to rations resulted in a pHdecrease in the rumen, probably due to a lower ammonium content and to an increasein volatile fatty acid production.
- Quote Garcia-Lopez et al. (1988): 2 wt% zeolite added to diary cow feed concentrate increased the milk fat percentage and the acid/base balance.

Effect of Clinoptilolite on Lactating Dairy Cows Fed a Diet Containing Urea as a Source of Protein.Hemken, R. W. et al. (1983) Department of Animal Sciences, University ofKentucky.

- Fecal pH was highest for the urea +clinoptilolite diet (5.64). Fecal starch followedthe same trend as fecalpH. A high fecal pH is desirable and can indicate improvedenergy utilisation. Other studies have shown that as fecal pH increases, fecal starchdecreases. Lower fecal starch indicates more complete digestion of dietary starch.
- The effects of fecal starch and fecal pH suggest an effect similar to that noted forlimestone and magnesium oxide.
- Body weights were not different due to diets, i.e. zeolite (6%) vs. control.
- Rumen ammonia was lowered by the addition of zeolite. Lower rumen ammonia isconsidered indicative if improved utilisation of protein.
- The data demonstrated that clinoptilolite alters protein metabolism by reducing bloodurea-nitrogen and affects pH in the lower gastrointestinal tract; however, thesebeneficial changes were not accompanied by increased milk yield.
- A soybean meal (protein source) plus 0.5% urea produced a significant increase inmilk yield.
- The blood plasma urea-nitrogen (BUN) was not significantly lower with the additionof zeolite. It was significantly lower in the soybean meal diet.

- Milk fat and milk protein concentrations were not affected by diet.
- Serum Ca, Mg, K and Na were not affected by diet.
- Cows past their peak lactation period were used. Recommended trials on diary cowsin an earlier stage of lactation (may be more responsive).
- Trials led to suggested designs for further study involving developing the optimumzeolite/protein diet.

Effect of Dietary Clinoptilolite on Digestion and Rumen Fermentation in Steers.
Sweeney T. F. et al. (1983) Pennsylvania State University

- The ability of zeolites to release ammonium ions gradually is beneficial for microbialsynthesis in the rumen, especially in diets containing a high level of no protein nitrogen.
- Carried out tests to determine if 5% dietary zeolite (<50 mesh), by nature of itsaffinity for water and osmotically active cations, affects the rate of passage of liquid digestion from the rumen.
- No differences in the growth rate or average daily intake due to the use ofclinoptilolite were noted.
- Zeolite added to a high N-solubility (HNS) diet resulted in increases in both apparentprotein and organic matter digestion.
- The zeolite had an affect on acid-detergent fibre (a major component of organic matter)digestion, increasing fiber digestibility possibly due to the maintenance ofsuitable levels of NH3 for enhanced microbial growth in the rumen.
- Fecal dry matter was increased by the addition of clinoptilolite to the diet. Theincreased fecal dry matter percentage improves environmental conditions in highlyconfined feedlot situations. Decreases in moisture available for microbial growth in feces contributes to improved animal health through cleaner air and reduced diseasecommunication.
- Blood urea-N (BUN) was reduced when clinoptilolite was added to the high HNSdiet.
- Zeolite has affinity for cations other than NH4+ and it was noted blood K wasreduced by the presence of zeolite in the diets.
- It is well documented that feeding high roughage diets to ruminants is not commonlyassociated with high incidences of diarrhea.
- Trial 2: No effect of dietary clinoptilolite was found on rumen pH or NH3.
- Organic-matter digestibility (3.5% - 4.5%) was increased by the addition ofclinoptilolite to the diet. This response may be related to physical and/or chemical interactions between clinoptilolite, rumen microbes and forage fiber particles.
- Noted no differences in fluid digestion flow from the rumen.
- Improved digestion and metabolism. Improved fiber digestion and rumenfermentation.
- Zeolites promoted an increase rumen acetate production (the precursor of milk fat);feed additive for lactating diary cattle.

Influence of Zeolite on Growth and Metabolism in the Ruminant.
Sweeney T. F. et al. (1980) Ph. D. Dissertation, University of Kentucky.

- Determined clinoptilolite could be used to conserve free ammonia for rumenmicrobial fermentation and thereby improve nutrient utilisation by ruminant animals.
- Demonstrated improved nitrogen, organic matter, and acid-detergent fiberdigestibility when 5% clinoptilolite was added to a high-solubility protein diet

ofgrowing steers and heifers.

Addition of Clinoptilolite to the Diets of Feeder Cattle.
Hutcheson, D. P. (1983) Texas Agricultural Experiment Station

- Clinoptilolite (-40 mesh) was added to replace 3% and 5% of diets.
- An adaptation period of two weeks appeared to be required for animals on a dietcontaining 3% clinoptilolite before intake levels become stabilized. Differingpercentages of zeolite, variable results, most nil and some reduced weight gainsrelative to controls.
- Serum Na was significantly lower after 56 days and whole blood K and serum Pincreased significantly at 7 days for the animals on the C20 diet. Na and K are notstored by the body and must be supplied daily in the diets. Thus, shifts in serum Naand whole blood K indicate that Na and K levels in the diet must be controlled whenfeeding clinoptilolite.

The Effect of Zeolite (Clinoptilolite) on the Post-feeding Dynamics of N Metabolismin the Portal Vein, Jugular Vein and the Rumen fluid of Bulls.
Jacobi, U. et al. (1984)

- Bulls, live weight 300kg, Urea application 0.2g per kg liveweight, zeolite 2.5% per kgdry matter. After urea administration, Zeolite reduced the ammonia concentration inthe rumen by 20 – 40% and in the v. portae by\ 60 – 70% in comparison with thecontrol group.
- In v. jugularis in the 90th minute after feeding significant hyperammonemia wasobserved in bulls with no zeolite supplement.

Sorption Characteristics of Natural Zeolite (Clinoptilolite) in Biological Material in Vitro.
Vrzgula, L. and Seidel, H. (1989)

- The sorption by clinoptilolite of arsenic, cadmium, and lead ion from the rumen andabomasum juice was investigated in laboratory conditions.
- Zeolite was found to sorb 91% of lead and 45% of cadmium from rumen fluid in 24hours. The sorption effectiveness was even higher from abomasum juice wherezeolite absorbed 98% lead in 24 hours.

Kondo et al. (1969)
• Reported that clinoptilolite added to the feed of young calves improved growth rate decreased the incidence of diarrhea (cited by Mumpton and Fishman, 1977).

Homo-Immuno Parameters in Newborn Calves
Nik-Khan A., (2002) Faculty of Agriculture, Tehran University, Iran, Zeolite '02.

- Neonatal calves are born with no immunoglobulin in blood sgatam and rely onimmunoglobulin from colostrum through passive immunity transfer.
- Male and female Holstein calves were fed maternal colostrum plus zeolite (0.5, 1.0,1.5 and 2.0 grams per kg of bodyweight per day).
- 1gram clinoptilolite per kg of body weight per day had the best effects on increasingserum immunoglobulin, vitamin A adsorption, average daily weight gain, reductionof fecal score and reduction of morbidity and mortality.

Calves in the Postnatal Period
Vrzgula L., (1988) Veterinary University, Czechoslovakia; Jacobi. U. Animal Production and Veterinary Medicine, Humboldt University, Germany.

- Health problems such as alimentary diarrhoea can cause the death of calves up to thesecond week of life. Treatment with antibiotics is not always effective.
- Zeolite (clinoptilolite) was added (1gram per kg of body weight at every feed) to thecolostrum of newly born claves up to the 15th day of life.
- The zeolite decreased the occurrence of both diarrhoea of alimentary origin and anassociated respiratory syndrome in comparison to the control. This treatment offers apossibility to decrease the use of expensive antibiotics.
- The zeolite fed calves had a statistically significant increase in the concentration ofimmunoglobulins in the blood serum.
- The zeolite improved the absorption of immunoglobulins, total proteins and somemicroelements, especially iron and copper.
- Mechanisms for the positive protective effect of zeolite on the incidence and courseof diarrhea in the alimentary canal: increase in adherence of enteropathogenic E.coli; alteration of metabolic acidosis through effects on osmotic pressure in the lumenof intestines.

Nitrogen Nutrition of Cattle in the Southern NT.
Phillips A., (2000) Senior Animal Production Officer, Department of Business, Industry and Resource Development, Alice Springs.

- Nitrogen is an essential animal nutrient required for protein formation (majorcomponent of muscle, skin and hair). The N is contained in amino acids, the buildingblocks of proteins. Amino acids and therefore proteins contain 16% nitrogen. Tocalculate the crude protein content of a feed multiplies the N content by 6.25. Plantprotein levels are highest in actively growing tissue and in seeds.
- Mature cattle require 6 – 8% crude (plant) protein in the diet to maintain liveweight.
- Cattle: on entry to the rumen, plant protein is broken down by microbes, that use theprotein to grow and reproduce. These microbes are then passed from the rumen anddigested in the abomasum (fourth stomach). The majority of protein digested andused by cattle is microbial protein.
- Some nitrogen from plant protein broken down in the rumen is absorbed across therumen wall as the gas ammonia. The ammonia is absorbed into the bloodstream,converted to urea in the liver and recycled in saliva. Excess urea is excreted in urine.
- Some proteins escape microbial breakdown in the rumen and are passed to theabomasum. These are called bypass proteins. Bypass protein is more efficientlydigested than microbial protein because there is less nitrogen loss as ammonia.Protein can be protected from breakdown in the rumen by plant substances calledtannins, resulting in bypass protein. High tannin can result in some protein escapingdigestion altogether, reducing feed value.
- Protein levels often fall below maintenance requirement in dry feed. This slowsrumen microbial activity because microbes cannot grow and reproduce as quickly asnormal. Slower feed breakdown results, and less microbial protein passes to thefourth stomach. Feed intake is reduced because the time feed spends in the rumen isincreased.

Mycotoxins

Surfactant Modified Zeolites.New Efficient Adsorbents for Mycotoxins.
Tomasevic-Canovic, M. et al. (2002), Belgrade, Yugoslavia and College of Veterinary Medicine, University of Missouri.

- Mycotoxins are toxic secondary metabolites produced by certain fungi in a number ofagricultural products. Mycotoxins contamination may affect as much a 25% of theworld's food crops.
- The prevention of mycotoxicosis in livestock can be achieved by the inclusion ofmineral adsorbents to bind mycotoxins, thereby decreasing their bioavailability.
- Zeolites effectively absorb mycotoxins containing polar groups, such as aflatoxins.
- Organic modification with amines (surfactant) enables the zeolite to adsorb less polarmycotoxins.

Prevention of Aflatoxicosis in Farm animals by Means of Hydrated Sodium Calcium Aluminosilicate Addition to Feedstuffs: a Review
Ramos, A. J. and Hernandez E. (1997), Spain.

- Mycotoxins are a wide group of fungal toxins that have been associated with severetoxic effects (mycotoxicosis) in man and animals. Aflatoxins are the most dangerousof these secondary metabolites.
- There is no definitive way to achieve complete detoxification of food and feedcontaminated with mycotoxins.
- Some natural zeolites have a high affinity to absorb aflatoxins, thereby having aprotective effect against the development of Aflatoxicosis in farm animals.
- Paper postulates a mechanism for the protective effect against aflatoxicosis generatedby a sorbent compound obtained by from a natural zeolite.

Minerals for Animal Feed, in a Stable Market.
Loughbrough R., (1993) Assistant Editor, Industrial Minerals

- The use of clays as carriers allows the addition of vitamins; minerals, antibiotics andother active compounds to the feed mix in concentrations under 0.1%.
- Perlite and vermiculite also remove pesticides present in feedstuffs by adsorption andexcretion, thus reducing the level of pollutants in both thee animal's body and milk.
- Perlite slows the progress of feed through the digestive tract and controls the releaseof nutrients in the gut. It is also capable of absorbing microorganisms and othercomponents during the process of fermentation in a ruminant's gut.
- Zeolites can be used as binding agents in animal feeds.
- Zeolite's primary values are as growth promoters and carriers of nutrients.
- As growth promoters zeolites appear to act as a buffer in the animals digestivesystem, storing nitrogen in the form of ammonium and releasing it gradually by ionexchange with sodium and potassium. The animal receives greater benefit from thesame quantity of feed.
- The ammonium absorbing characteristics result in drier feces and an improvedatmosphere in the stables.

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