BEAR RIVER ZEOLITE

DAIRY RESEARCH REVIEW

The benefits of clinoptilolite, a volcanic mineral

Clinoptilolite is one of the most useful naturally occurring zeolites, but remains relatively unknown. Recent studies have uncovered benefits for dairy cattle that support health, reproduction and milk production. As we studied the research used for this review, we noticed patterns and connections between the metabolism of the dairy cow and clinoptilolite. The detailed methodology used in current research has uncovered possible explanations for the positive results.

This document was prepared to provide a compilation of data from world-wide zeolite (clinoptilolite) studies to be used as an informational resource. Benefits from studies cannot be claimed by Bear River Zeolite, Co. due to U. S. and Canadian government restrictions.

Clinoptilolite stands apart from other additives with beneficial results in a broad range of applications.

HEALTH AND PRODUCTIVITY

- REDUCED INCIDENCE OF HYPOCALCEMIA
- REDUCED INCIDENCE OF KETOSIS
- IMPROVED ENERGY STATUS
- INCREASED ABSORPTION OF IgG FROM COLOSTRUM
- DECREASED INCIDENCE OF CALF DIARRHEA

METABOLISM

- INCREASED MILK PRODUCTION
- LOWER SOMATIC CELL COUNTS
- BETTER UTILIZATION OF NITROGEN
- BUFFERS pH

NUTRITION

- AVAILABLE DIETARY NUTRIENTS
- STABLE HEMATOLOGICAL PARAMETERS

TOXIN AND PATHOGEN ADSORPTION

- REDUCED AFLATOXIN B1
- REDUCED AFLATOXIN M1 IN MILK
- REDUCED FLORA LEVELS

MANURE MANAGEMENT

- AMMONIA LOSS REDUCTION
- ODOR AND MOISTURE CONTROL
- INCREASES NITROGEN VALUE OF MANURE

BEAR RIVER ZEOLITE, PO Box 643, 47 Cox Gulch Road, Thompson Falls, MT 59873
406-827-3523 • FAX: 406-827-3543 • www.bearriverzeolite.com • tfl3543@blackfoot.net

Clinoptilolite added to the dry cow diet four weeks before calving has been shown to improve the cow's ability to reach full potential throughout lactation.

Negative impacts for dairy cattle*	Ketosis	Milk Fever	Aflatoxicosis
Appetite reduction	✓	✓	✓
Reduced milk production	✓	✓	✓
Liver damage	✓	✓	✓
Compromised immune system	✓	✓	✓
Impaired reproduction	✓	✓	✓
Reduced feed conversion	✓	✓	✓
Intestinal disorders	✓	✓	✓
Early culling	✓	✓	✓
Reduced weight gain	✓	✓	✓
Increased mortality	✓	✓	✓
Displaced abomasum	✓	✓	
Metritis	✓	✓	
Mastitis	✓	✓	

MILK FEVER (SUB-CLINICAL AND CLINICAL HYPOCALCEMIA) (Katsoulos2005)

Almost all dairy cows experience hypocalcemia (milk fever) in early lactation to some degree as they balance energy demands for body maintenance and milk production. Clinical and sub-clinical hypocalcemia, which can go undetected, are high risk factors for other complications (see table).

- Cows fed 1.25 or 2.5% clinoptilolite in concentrate starting at **4 weeks before calving had reduced incidence of hypocalcemia** and was less severe when it did occur.

Incl. Rate	No. of cows	No. w/Hypocalcemia
1.25%	17	3
2.5%	17	1
None	18	7

KETOSIS (Katsoulos, P.D., et al., 2006) *

The **incidence of clinical ketosis in early lactation ranges from 40 to 50%**. This estimate is low due to unrecognized subclinical (unrecognized) ketosis cases.

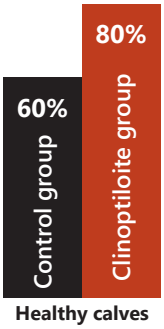
- Occurs in the first 2 to 6 weeks after calving with a large number of incidences at 5 days in milk.
- The cost of one case of ketosis is estimated at **$289 per cow** and can impact **annual economic losses on a 1000 cow herd by almost $90,000**.

Long term feeding of 1.25 and 2.5% clinoptilolite added to the concentrate showed positive results:

- **Serum concentrations of glucose (energy source) were higher on the day of calving.**
- **Higher milk yield** and **improved energy status**, possibly due to an increase in the production of propionate in the rumen and more complete digestion.

Fed four weeks before calving until the beginning of the dry off period

Incl. Rate	No. of cows	No. w/Ketosis
1.25%	17	6
2.5%	17	1
None	18	7



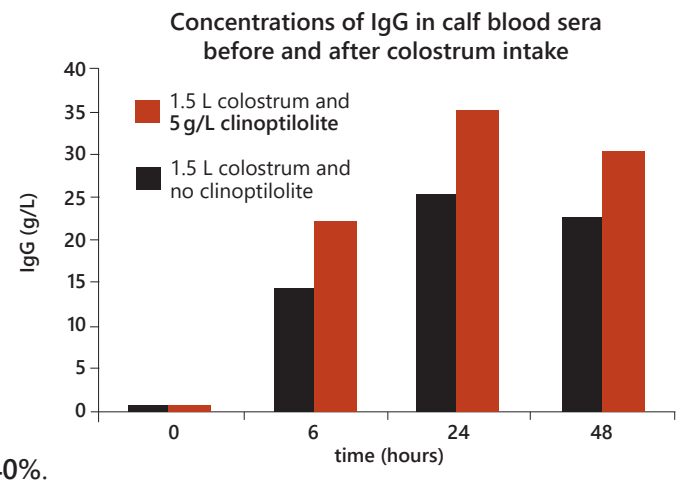
Clinoptilolite inclusion in colostrum resulted in healthier calves and lower incidence of diarrhea.

CALVES

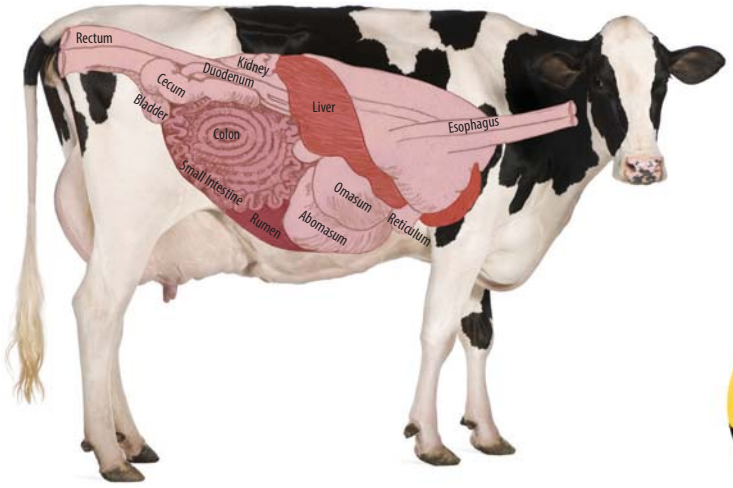
(Fratric, N. et al., 2005) (Zarcula, S., et al., 2010) (Gvozdic, D., et al., 2008)

The survival rate and health of calves correlates with the transfer of passive immunity (IgG [immunoglobulin]) from colostrum feeding in the first 24 to 36 hours of life.

- **Clinoptilolite added to colostrum reduced the incidence of diarrhea**.
- Colostrum combined with 5 g/L clinoptilolite has been shown to **increase the absorption rate of colostral IgG by 40%**.



METABOLISM

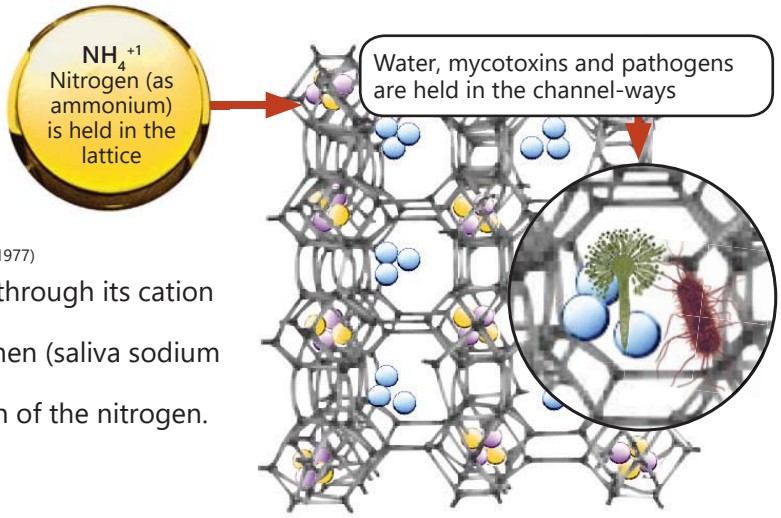


MILK PRODUCTION (Ural, D.A. 2014) (Karatzias, M.A., et al., 2013) (Katsoulos, P.D., et al., 2006)

Clinoptilolite added to the diet four weeks before calving:

- **Increased milk production**.
- **Lowered somatic cell counts**.

An **increase of propionate** in the rumen and the **increase in intestinal digestion of starch** with clinoptilolite inclusion **improved the energy status** needed for milk production.



Clinoptilolite lattice and channel-ways

EFFICIENT UTILIZATION OF NITROGEN (Eng, K.S., 2003) (White, J.L., et al. 1977)

Clinoptilolite has the ability to capture ammonium from feed through its cation exchange capacity (CEC).

- Ammonium is released when it comes back to the rumen (saliva sodium exchanges with the ammonium)
- **"Time release" of the ammonium** for better utilization of the nitrogen.

BUFFERS pH (Eng, K.S., 2003) (McCollum, F.T., 1983)

Feeding **high calcium** clinoptilolite **buffers rumen pH**.

TOXIN AND PATHOGEN ADSORBTION

MYCOTOXINS (Katsoulos, P., et al., 2016) (Tomasevic-Canovic, M., et al., 1997) *

AFB1 is classified as a carcinogen and is produced by *Aspergillus flavus* mold, a common mycotoxin found in feed.

- AFB1 is metabolized in the liver to produce **AFM1** which **ends up in the milk within 12 hours**.
- **AFM1** in dairy products is **highly toxic** and has **carcinogenic properties**.
- **Pasteurization is ineffective** for the reduction or elimination of AFM1 in milk products.
- Negative effects are more severe for the young (humans and animals).

Aspergillus flavus (B_1)

Clinoptilolite adsorb mycotoxins on the channel-way surfaces. One gram of clinoptilolite can adsorb 200 µg (0.2 mg) of AFB1.

- **AFB1 and AFM1 effectively reduced** with the addition of 1% clinoptilolite (per cow per day) in the dry matter ration or 200 grams in the total mixed ration (per cow per day).
- A smaller particle (<0.15 mm) is more effective due to the increased clinoptilolite surface area.
- **56.2% average reduction of AFM1 concentrations in milk**.

Clinoptilolite has also been shown to adsorb zearalenone, ochratoxin, alfatoxin B2 and G2.

PATHOGEN REDUCTION (Al-Nasser, A.Y., et al., 2001) (Mallek, Z., et al., 2012)

Clinoptilolite also captures pathogens in the large surface area of the clinoptilolite channel-ways.

- Feeding clinoptilolite **reduced intestinal flora** levels, **including salmonella**.
- **Clinoptilolite has also been shown to bond with *E. coli* (*Escherichia coli*).**

Salmonella

NUTRITION

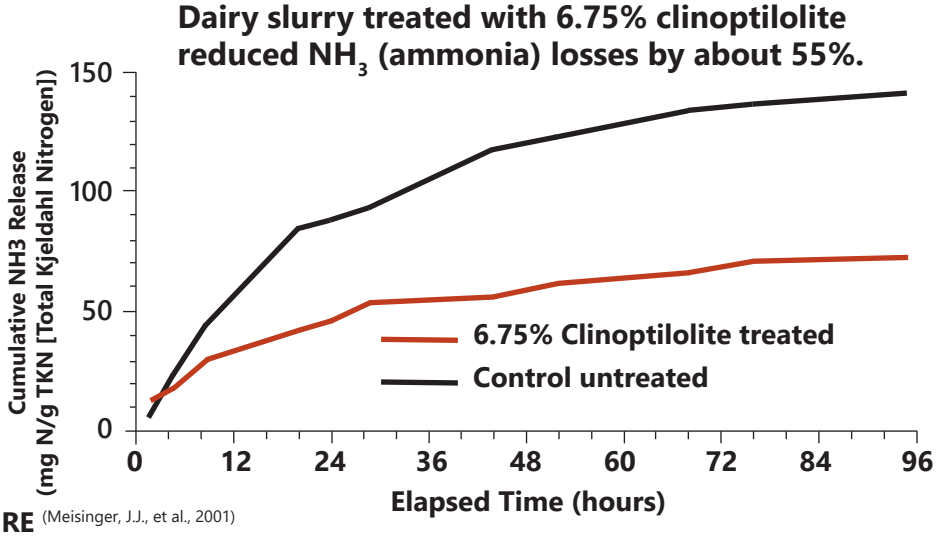
AVAILABLE DIETARY NUTRIENTS (Karatzia, M.A., et al. 2016) (Tomasevic-Canovic, et al., 2000) (Katsoulos, P.D., et al., 2005) (Katsoulos, P.D., et al., 2005)

Long-term supplementation with 1.25 or 2.5% clinoptilolite in the concentrate **did not adversely effect blood serum concentrations of tCa (total calcium), PO_4^{-2}, Mg^{+2}, K^+, and Na^+** and **beta-carotene, vitamins A and E**.
Long-term feeding of clinoptilolite 200 g in the ration had no adverse effects on **dietary availability** of **Cu, Zn, and Se**.
In vitro studies of clinoptilolite showed **positive results for the availability of Cu, Zn, Se, Co, Mn and vitamin A, D, and E and only slight binding of B6**, in contrast to reductions in availability with montmorillonite and bentonite by comparison.

STABLE HEMATOLOGICAL PARAMETERS (Katsoulos, P.D., et al., 2005)

Clinoptilolite added to the concentrate at 1.25% and 2.5%, starting 30 days before calving until the end of lactation, did not adversely effect:

- **PCV** (Packed cell volume)
- **Hb** (hemoglobin)
- **WBC** (White blood cell count)



INCREASES NITROGEN RETAINED IN MANURE (Meisinger, J.J., et al., 2001)

Ammonia (NH_3) from agriculture is estimated at 90% of the total NH_3 emissions in the U.S. and Western Europe. The loss of NH_3 has become a major focus for air quality and has prompted support for regulatory policies. Additionally, economic loss occurs on farms when NH_3 ends up in the atmosphere instead of the slurry used to fertilize fields.

CATION EXCHANGE CAPACITY (Meisinger, J.J., et al., 2001)

The high cation exchange capacity (CEC) of clinoptilolite enhances the capture of ammonium before it vaporizes to ammonia (gas).

- **Dairy slurry treated with 6.75% clinoptilolite reduced NH_3 (ammonia) losses by about 55%.**
- **Reduced water-soluble P (phosphorus) losses by 35%.**

ODOR AND MOISTURE CONTROL (Meisinger, J.J., et al., 2001)

One of the major causes of odor from animals is the generation of ammonia gas from urea and manure that become the aerosol for odors.

- **Clinoptilolite holds 55% of its weight in water.**
- **Clinoptilolite reduced odor** by capturing ammonium.
- Slurry was dryer and easier to handle.

REFERENCES:

Al- Nasser, A.Y., Al-Zenki, S.F., Al-Saffar, A.E., Abdullah, F.K, Al-Bahouh, M.E. and Mashaly, M. 2011. *Zeolite as a feed additive to reduce Salmonella and improve production performance in broilers*. Intl. J. Poultry Sci. 10(6): 448-454.

Eng, K.S., R. Bechtel and D. Hutchenson, 2003. Adding a potassium clinoptilolite zeolite to feedlot rations to reduce manure nitrogen losses and its impact on rumen PH, E. coli and performance. Proceedings of S.W. Nutr. and Mngt. Conf. 18th Annual, Feb. 2003, Arizona, USA.

Fratric, N., Stojic, V. Janovic, D., Samac, H., and Gvozdic, D. 2005. *The effect of a clinoptilolite based mineral adsorber on concentrations of immunoglobulin G in the serum of newborn calves fed different amounts of colostrum.* J. Acta Veterinaria. 55 (1): 11-21.

Gvozdic, D., Stojic, V., Samanc, H., Fratric, N., and Dakovic, A. 2008. *Apparent efficiency of immunoglobulin absorption in newborn calves orally treated with zeolite.* J. Acta Veterinaria. 58 (4): 345-355.

Karatzia, M.A., Katsoulos, P.D., Karatzias, H., and Karatzias, H. 2013. *Diet supplementation with clinoptilolite improves energy status, reproductive efficiency and increases milk yield in dairy heifers.* Ani. Prod. Sci. 53: 234-239.

Karatzia, M.A., Katsoulos, P.D., Karatzias, H., and Zener, A. 2016. *Blood selenium, copper, and zinc in dairy heifers during transition period and effects of clinoptilolite administration.* Czech. J. Anim. Sci., 61(3): 133-139.

Katsoulos, P., Karatzia, M., Boscos, C., Wolf, P. and Karatzias, H. 2016. *In-field evaluation of clinoptilolite feeding efficacy on the reduction of milk aflatoxin M1 concentration in dairy cattle.* J. Ani. Sci. and Tech. 58 (24).

Katsoulos, P.D., Panousis, N., Roubies, N., Christaki, E., and Karatzias, H. 2005. *Effects on blood concentrations of certain serum fat-soluble vitamins of long-term feeding of dairy cows on a diet supplemented with clinoptilolite.* J. Vet. Med. A 52: 157-161.

Katsoulos, P.D., Roubies, N., Panousis, N., Christaki, E., Karatzanos, P., and Karatzias, H. 2005. *Effects of long term feeding dairy cows on a diet supplemented with clinoptilolite on certain haematological parameters.* Vet. Med. – Czech, 50 (10): 427-431.

Katsoulos, P.D., Panousis, N., Roubies, N., Christaki, E., Arsenos, G., Karatzias, H. 2006. *Effects of long-term feeding of a diet supplemented with clinoptilolite to dairy cows on the incidence of ketosis, milk yield and liver function.* Vet. Record 159: 415-418.

Katsoulos, P.D., Roubies, N. Panousis, N., Arsenos, G., Christaki, E., Karatzias, H. 2005. *Effects of long-term dietary supplementation with clinoptilolite on incidence of parturient paresis and serum concentrations of total calcium, phosphate, magnesium, potassium, and sodium in dairy cows.* Am. J. Vet. Res. 66 (12).

Mallek, Z., Fendri, I., Khannous, L., Hassena, A.B., Traore, A.I., Ayadi, M. and Gdoura, R. 2012. *Effect of zeolite (clinoptilolite) as feed additive in Tunisian broilers on the total flora, meat texture and the production of omega 3 polyunsaturated fatty acid. Lipids in Health and Disease.* 11: 35.

McCollum, F.T., Galyean, M.L. 1983. *Effects of clinoptilolite on rumen fermentation, digestion and feedlot performance in beef steers fed high concentrate diets.* J. Ani. Sci. 56 (3): 517-524.

Meisinger, J.J., Lefcourt, A.M., Van Kessel, J.A.S., and Wilkerson, V. 2001. *Managing ammonia emissions from dairy slurry with alum or zeolite or by diet modification.* Proc. 2nd Intl. Conf. on Sci. and Policy. 1(S2): 860-865.

Tomasevic-Canovic, M., Dakovic, A., Markovic ,V., Radosavljevic-Mihajlovic, A., and Vukicevic.J. 2000. *Adsorption effects of mineral adsorbents; Part III: Adsorption behaviour in the presence of vitamin B6 and microelements.* J. Acta Veterinaria. 50: 23–29.

Tomasevic-Canovic, M., Dakovic, A., Markovic ,V. and Stojsic, D. 2001. *The effect of exchangeable cations in clinoptilolite and montmorillonite on the adsorption of aflatoxin B1.* J. Serb. Chem. Soc. 66(8): 555-561.

Tomasevic-Canovic, M., Dumic, M., Vukicevic, O., Masic, Z., Zurovac-Kuzman, O., and Dakovic, A. 1997. *Adsorption of mycotoxins on modified clinoptilolite.* Natural Zeolites Sofia '95, Pensoft, Sofia: 127-132.

Ural, D.A. 2014. *Efficacy of clinoptilolite supplementation on milk yield and somatic cell count.* Rev. MVZ Cordoba 19(3):4242-4248.

White, J.L., and Ohlrogge, A.J. 1997. *Ion exchange materials to increase consumption of non-protein nitrogen by ruminants.* U.S. Patent 4393082.

Zarcula, S., Tulcan, C., Samanc, H., Kirovski, D., Cernescu, C.M. 2010. *Clinical observations in calves fed colostrum supplemented with clinoptilolite.* Lucr. St. Med. Vet., XLIII: 64 – 68.

*Additional references for background information on file at Bear River Zeolite Co.