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1. INTRODUCTION. Environmental issue

Excessive application of manure increased soil nutrient concentrations (N and P), resulting in the contamination of downstream water bodies (nitrates) and in the overgrowth of aquatic plants (green tides)¹. The most logical solution is to find an economical and viable way of improving feed digestion. Zeolite has the potential to improve nutrient digestibility by reducing manure N and P content and therefore avoiding unpleasant manure odors.

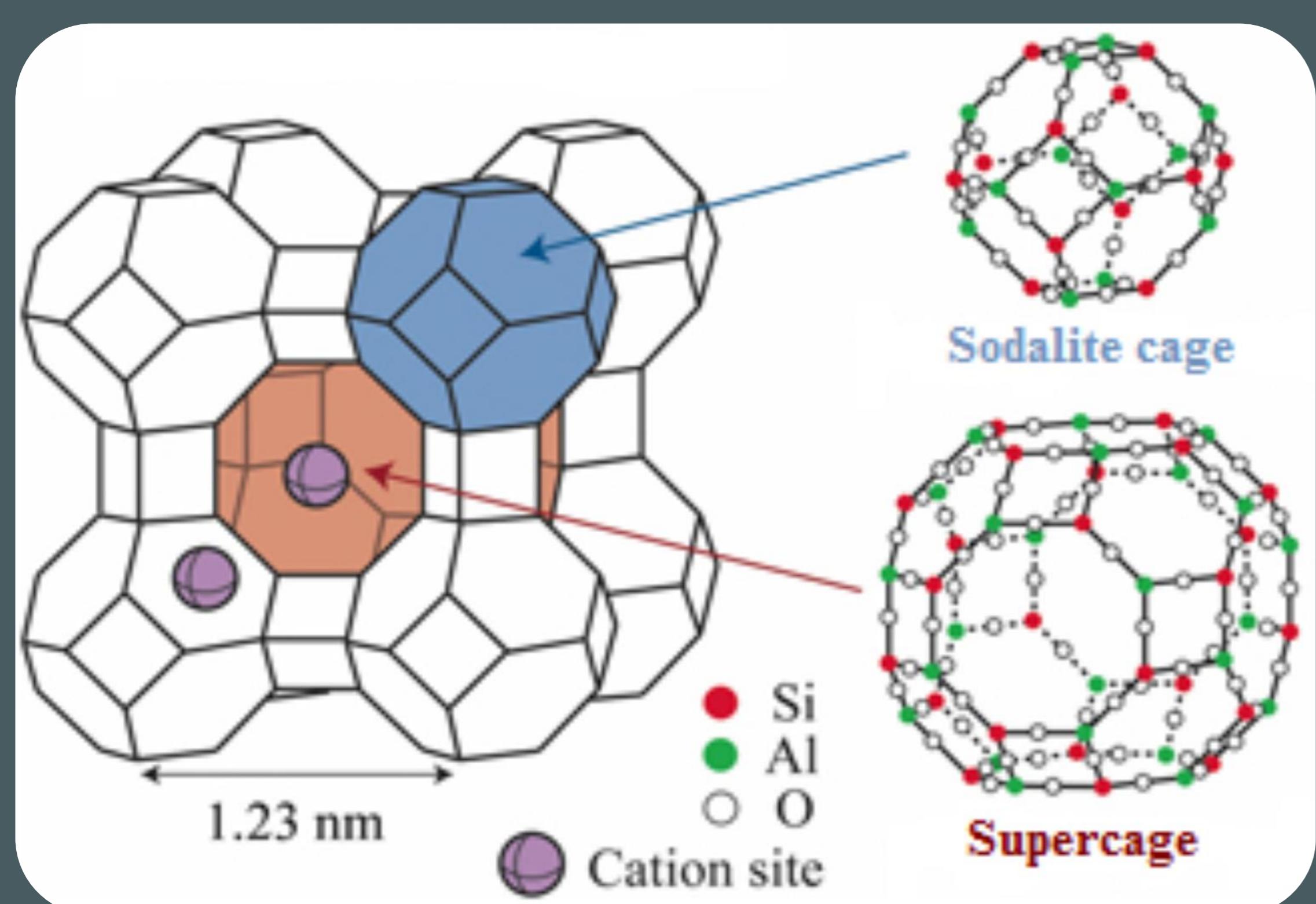
2. OBJECTIVES

This review evaluates zeolite effects on feed digestion, growth performance and manure characteristics (especially N and P levels) in swine, poultry and fish. The objectives are:

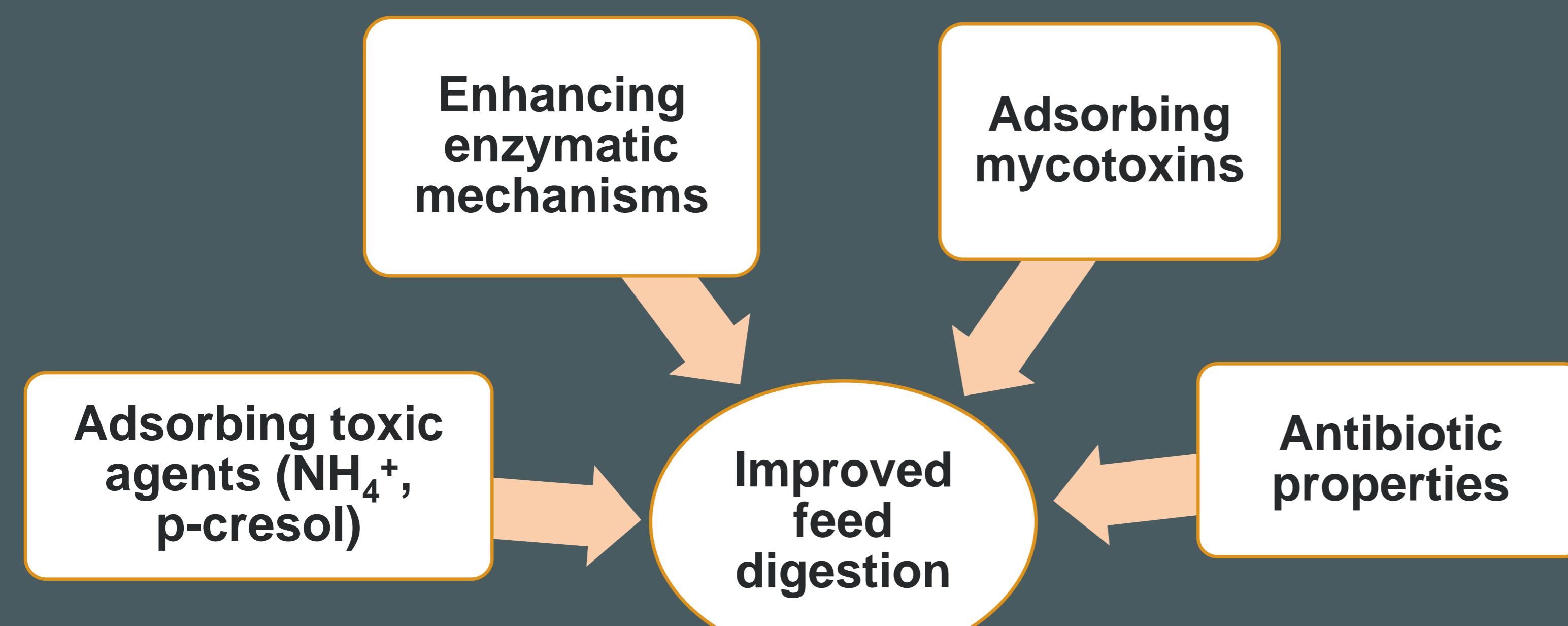
- to analyze the effects of feed supplementation
- to understand the mechanisms of action of this mineral
- to conclude as to its most appropriate mode of use

3. ZEOLITES

Zeolites are crystalline aluminosilicates having infinite three-dimensional structures with interconnecting channels and large cavities capable of trapping molecules¹.



They exhibit a negatively charged framework counterbalanced by positive cations². The interest of zeolites concerns ion exchange capacity, adsorption² and related molecular sieving properties¹. Clinoptilolite (Cp) is the most widely used natural zeolite due to its structural stability and high affinity for NH_4^+ .



Mechanisms which explain the potential of zeolite to improve animal feed digestion

This mineral could increase the intestine viscosity hence slowing down the passage rate of digesta. Thus, an increased transit time of digesta may allow the endogenous enzyme activity³. Zeolite can favor the digestive process by adsorbing NH_4^+ and mycotoxins, and modifying the gastrointestinal tract's flora due to its antibiotic properties (buffer capacity)^{1, 2}.

4. STUDIES IN SWINE, POULTRY AND FISH

In multiple studies using zeolite in feed, higher intake levels are observed probably due to the dilution of the diet associated with the incorporation of the mineral additive³. Blood serum biochemical parameters were generally within the normal range¹. Zeolite does not affect palatability and the maximum recommended incorporation is of 10% of natural zeolite in feed.

The supplementation level, purity and type of zeolite as well as the growth phase of animals could be important factors affecting productive performance.

Effect of zeolites on productive parameters and manure characteristics in different animal species

Animal species	Productive parameters	Manure characteristics
Swine	Variable results (FW, GR, DFI, ADG, FCE)	Lower N and P levels and less odors
Poultry	Variable results (GR, DFI, FCE)	Lower N and P, less odors Reduced moisture litter
Fish	Variable results (depending on fish species)	Decrease in total and dissolved N losses

ADG = average daily gain; DFI = daily feed intake; FCE = feed conversion efficiency; FW = final weight; GR = growth rate

The Cp in feed does not clearly enhance productive parameters in many animal species. However, zeolites are absolutely able to reduce N and P excretion in manure and slurry. They adsorb NH_4^+ , there is less ammonium (toxic) metabolized to urea, and therefore, less urea excretion in urine. In the digestive tract, zeolites are capable of retaining N in its structure and, that is why the N levels diminish in feces. This additive reduces moisture in litter and excrement of poultry because it can absorb more than 60% of its weight in water¹. Odors are significantly reduced².

Other interesting aspects, zeolite minimized the incidence of intestinal diseases in many species. The Cp also proved to exert a promoting effect on sow's reproductive performance².

5. CONCLUSION

Further research with different levels of Cp should be conducted to better understand the effects of zeolite on growth performance. It is still necessary to determine the terms of use of this additive (incorporation level in diet for every species). It is important to bear in mind the cost of this mineral. Finally, zeolite is probably not particularly effective as a growth promoter, but it presents other profitable effects that can be very useful in animal production (reducing enteritis, adsorbing mycotoxins and other toxic agents). Other experts affirm that it would be more useful to apply Cp directly on the excrement.

6. REFERENCES

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2. Subramaniam M.; Kim I.H. 2015. *J Anim Sci Biotech*, 6:38.
3. Zhou P. et al. 2014. *Asian-Australas J Anim Sci*, 27:1311-1318.