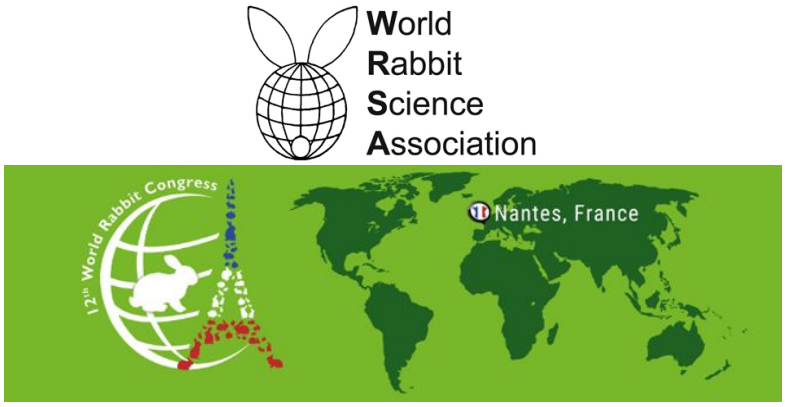

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BENTONITE IN RABBIT FEEDING – A SHORT REVIEW

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ABSTRACT

Bentonite can be safely used in rabbit diets up to 2% (legal maximum in Europe). Sodium bentonite can efficiently improve pellet quality, even in presence of additional fat, but not higher than 6%. Calcium bentonite incorporation in the diet is an efficient mycotoxins binder able for example to nearly suppress the negative effect of aflatoxins. As a negative aspect, presence of bentonite in the diet is incompatible with the efficiency of most coccidiostats.

Key words : rabbit, bentonite, pelleting, binder, detoxification, coccidiostats

INTRODUCTION

According to the scientific opinion of the *ad hoc* committee of the European Union, bentonite a natural clay (E558) can be used in Europe as technological feed additive for all types of animal up to 2% of the complete diet (European commission rule N°1030/2013 regularly confirmed by EFSA, 2012, 2017). Up to this level (at least) bentonite is considered as safe for all animals, consumers, workers of the feed industry and environment.
However, in the publications of this committee in relation with bentonite use in animal feeding, there is no specific mention of its utilization or efficacy in rabbit feeding (EFSA 2011 a b, 2012, 2013, 2017). Therefore, the object of this short review is to summarize international literature available on interest, efficacy and risks associated with bentonite utilisation in rabbit feeding.

BENTONITE DEFINITION

Bentonite or more precisely bentonites are a group of clays formed in many places of the World from volcanic ash that accumulated in the water and formed clay layers. The initial name was given by geologists in the middle of the19th century for a type of clay observed near of Fort Benton in the Wyoming (USA). It is composed mainly of montmorillonite, an aluminosilicate of the smectites group. European directive 2008/84/EC sets for bentonites intended for use in food a minimum montmorillonite content of 80 %. Smectites and among them montmorillonite are phyllosilicates characterised by a sheet structure made of layers of polyhedra of silicon oxide with tetrahedral coordination between which there is an octahedral layer This structure favours largely the adsorption of ions but also of proteins and lipids. Bentonite is used mainly for industrial purpose, but also for food or feed industry and cosmetics. The 2 main types of bentonite are the sodium bentonite known for it's ability to largely expand when wet, absorbing water as much as 5 to 10 times its dry mass. The second type is calcium bentonite which is a useful adsorbent of ions in solution, as well as fats, oils and proteins, but absorbing water only 1 to 1.5 time its dry mass
In relation with their physicochemical properties bentonites can be used in animal feed to improve the pellets quality (mainly durability, in relation with the expansion-retraction ability of sodium bentonite) or to detoxify feedstuffs thanks to the possibility of sequestration of various types of ions and molecules between the thin layers (calcium bentonite).

BENTONITE AS PELLETING BINDER

In order to reduce the proportion of fine particles in commercial pellets, during the years 1970-80 bentonite was commonly used as pellet binder for rabbit feeds at a level of about 2% (Cheeke 1987). In a experimental study on alfalfa pelleting, Tabil (1997) demonstrated that bentonite addition before

pelleting, effectively improves the durability and hardness of meals difficult to press but is not efficient if the initial meals provide pellets with a correct or a high durability (Table 1). It should be also noticed that the energy consumption of the pelleting machine was not significantly modified in the Tabil study.

Table 1 : Pelleting of chopped alfalfa hay without or with bentonite – Low, medium and high qualities were defined as the ability of the shopped alfalfa to provide good quality pellets without any addition (from Tabil , 1997)

Type of alfalfa	Durability, %		Hardness, N		Energy consumption, kWh/t	
	Control	5% bentonite	Control	5% bentonite	Control	5% bentonite
Low quality	65.1 b	88.8 a	507 b	701 a	29.2 a	29.2 a
Medium qualit	77.8 a	78.2 a	669 a	716 a	35.9 a	31.3 a
High quality	84.9 a	79.9 a	632 a	756 a	40.3 a	42.1 a

For fattening rabbits fed from 30 to 81 days, diets with 0 - 1 - 2 or 3% of bentonite, average daily gain, feed intake, feed conversion ratio as well as slaughter indices and mortality were not significantly different among groups (Lambertini et al., 1987). A similar absence of significant effects of sodium bentonite addition on growth performance was observed by Grobner (1983) with a higher inclusion level of 5% of the diet. However in this case a non significant increase of cecal impaction was mentioned. This may be in relation with the accumulation of bentonite in the cæecum (but without additional mortality) described by Lambertini et al. (1987) in their study.
According to these results, addition of up to 2-3% bentonite could be a safe solution to improve pellets quality. This solution was, for example, used in studies on the effect of different raw materials (Villamide et al., 1989; Carabaño et al., 1997) and particularly for studies on addition of sources of lipids in the diet (Meileelles et al., 1979; Fernandez and Fraga 1996; Fernandez et al., 1994). However if the presence of 2.5% sodium bentonite improves clearly the pellets durability of diets with 3% or 6% added fat, no significant improvement was observed with 9% of added fat (Salmon et al., 1985). It must also be mentioned that some little but significant growth performance or digestibility improvements were associated with the present of bentonite in the diet (Sarhan et al., 1997; Salma et al., 2016). In these cases the most probable explanation is a better health of rabbits due to the binding of some dietary or endogenous toxins inside of the bentonite (see next part of this review).

In different studies on rabbits, diets used for various purposes include 0.5 to 3% % of bentonite considered by the authors as a factor of security for the pellets quality (Carabaño et al., 1988; Diaz Arca et al., 1989; Bianospino et al., 2006; Lazzaroni et al., 2009). However it must be underlined that the inclusion of bentonite as factor of quality of the pellets was not mentioned for any of 91 short communications presented during the 2 last World Rabbit Congresses in the sections of Nutrition and Feeding.

BENTONITE AS DETOXIFCATION AGENT

Mycotoxins

Bentonite can be safely used in rabbit diets up to 2% (legal maximum in Europe). Sodium bentonite can efficiently improve pellet quality, even in presence of additional fat, but not higher than 6%. Calcium bentonite incorporation in the diet is an efficient binder of mycotoxins able for example to nearly suppress the negative effect of aflatoxins As a negative aspect, presence of bentonite in the diet is incompatible with the efficiency of most coccidiostats.

In the Egyptian study published by Amer et al. (2018), bentonite supplementation of diet (up to 2%) overcame the negative effect of 150 ppb of naturally occurring aflatoxin in fattening rabbits ration. It enhanced growth performance traits, decreased the relative weights of the liver and the kidney which are usually increased by aflatoxin, and decreased the histopathological lesions caused by aflatoxin-contaminated diets. Similarly, the addition of 0.5% of bentonite to a diet contaminated with 250 ppb of aflatoxin B1 reduce quite completely the negative impact of aflatoxin on rabbit growth (Table 2)

Table 2 : Effect on rabbits growth rate of addition 0.5% bentonite in a diet contaminated with 250 ppb aflatoxin B1, (from Hassan et al., 2019)

Diets	0 ppb aflatoxin	250 ppb aflatoxin	250 ppb aflatoxin +0.5% bentonite
10 weeks ADG (g/d)	28.9 a	11.7 c	25.3 b

With a ration contaminated with a higher level of aflatoxin B1 (850 ppb) the addition 2% of bentonite reduces largely the negative effect of aflatoxin on rabbits growth rate in a 90 days feeding study : 10.2 g/d for the contaminated diet, 28.5 g/d for control diet without contamination and 32.8 g/d for the contaminated diet supplemented with bentonite, all differences being significant at P=0.05 (Abu El-Zahab et al, 2012)
Addition of 1% of raw Egyptian bentonite to an aflatoxin contaminated diet improved the general physical semen characteristics of rabbit bucks and reproductive performance traits of rabbit does (Nowar et al., 2000). In the same manner, a supplementation of the diet with 0.4% bentonite reduces, but don't suppress, the harmful consequences for rabbit female reproduction, associated with utilization of a diet containing 135 or 180 ppb of aflatoxin B1+G1 (Meshreky et al., 2007).
From these experiments, it can be concluded that addition of bentonite, respecting a maximum of 2%, reduces effectively, even suppress completely, the negative effect of the presence of aflatoxin in the rabbits diets used for reproduction or fattening. However, no information seems available on the detoxification ability of bentonite for other known mycotoxins when present in rabbit diets.

Other pollutants

In addition to the action of bentonite against mycotoxins, this clay may have a favourable effect for decontamination of rabbit diets affected by accidental pollution. For example addition of 4% bentonite in rabbit diets contaminated with proenofos (an organophosphate insecticide) at 0.6 to 2.6 mg / kg, decreased mortality rate (3.3% vs 16.7%; P=0.097). It also increased the average daily gain during the experimental period of 8 weeks : 26.9 g/d for the control, 20.8 g/d in presence of proenofos and 24.7 g/d if bentonite is added to the contaminated diet. Feed conversion was also improved with clay supplementation of contaminated diets (Ayyat et al., 2000).

BENTONITE AND UNDESIRABLE BINDING OF SOME MOLECULES

In the description of use of bentonite in animal feeding, the European commission (2013) precise clearly that simultaneous oral use of bentonite with macrolides shall be avoided for all species. In the same decision, it was mentioned that simultaneous use of bentonite with robenidine shall be avoided, and that simultaneous use bentonite with other coccidiostats is contraindicated with level of bentonite above 0.5% of complete feed, a remark that can be easily extended to rabbits. This proposition was confirmed by the EFSA panel in 2018 for the salinomycin use in fattening rabbits diets. Similarly, decoquinate should not be used simultaneously with bentonite for fattening chickens (EFSA Panel, 2019). However, De Mil et al. (2017) failed to notice any significant effect of clay binders (based on montmorillonite) on the bio-availability of salinomycin or diclazuril in broiler chickens.

In addition to the interactions between bentonite and medicaments, the old paper of Briggs and Spivey Fox (1956) should be reminded : bentonite caused a vitamin A deficiency in chickens when fed at a level of 2-3%, or higher, in a synthetic diet otherwise containing ample amounts of vitamin A in un-stabilized form. Both sodium and calcium bentonites were active in this regard. All signs of deficiency were prevented by the use of stabilized vitamin A, by higher levels of vitamin A or carotene addition.

CONCLUSION

At the end of this short review it can be conclude that up to the legal level of 2%, bentonite can improve pellets quality and consequently rabbit performance. The addition of bentonite to a diet contaminated with mycotoxins or other chemical pollutants can alleviate, and even sometimes suppress, the negative effect of pollution. However, due to its high binding capacity, bentonite is incompatible with the use of most coccidiostats and many medicines.

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BENTONITE in RABBIT FEEDING
a review

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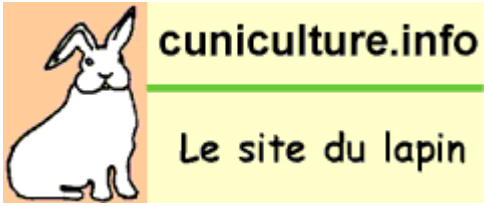

Bentonite : what is it ?

Bentonite is a natural clay derived from volcanic ashes available in many places around the world

It's sometimes called « the 1000 uses clay »
- industrial clay in boreholes,
- as support in cosmetic industry
- feed additive (maxi 2%)
- cats litter, wine clarification, foundry …etc…etc…

An alumino-phyllosilicate of the smectites familly, structured in many thin layers

2 main forms

- Sodium bentonite, wich can expand 5 to 10 times or more in presence of water, also able to capture small molecules between the layers

- Calcium bentonite, not expandable but able to capture small molecules

Uses of bentonites

Bentonite quarry in Greece

Raw bentonite

Industrial bentonite

Indian bentonite
food grade

Litter for cats

Industrial
Chinese bentonite

Bentonite as PELLETING BINDER

Pelleting of chopped alfalfa ± difficult to agglomerate

(From Tabil 1997)

Alfalafa Ease of pelleting	**Durability** (% fines)		**Hardness** (N)	
	Control	**+ bentonite**	Control	**+ bentonite**
Difficult	65	**89**	510	**700**
Medium	78	**78**	670	**720**
Easy	85	**80**	632	**760**

Bentonite as PELLETING BINDER
Influence on rabbit performance

0 – 1 – 2 or 3% Bentonite in growing rabbits diets
(Lambertini et al 1987)

⇒ **Absence of significant** effects on ADG, Feed Conversion ratio, Slaughter performance or Mortality

⇒Tendency for accumulation of bentonite in the caecum with the highest level

Addition of bentonite up to the legal level of 2%

- Factor of security and pellets quality for many authors in the past

- Since the last 10-15 years : utilisation less frequent , except after lipids addition in the diet

Bentonite as DETOXIFICATION AGENT

GROWING RABBITS

	0 ppb Aflatoxin	250 ppb Aflatoxin	250 ppb Afla. +0.5% Bentonite
ADG g/d	**29**	**12**	**25**

Hassan et al., 2019

	0 ppb Aflatoxin	850 ppb Aflatoxin	850 ppb Afla. + 2 % Bentonite
ADG g/d	**29**	**11**	**33**

Abu El Zahab et al., 2012

Bentonite as DETOXIFICATION AGENT

REPRODUCTION

	Control	180 ppb Aflatoxin	180 ppb Afla + 0.4% Bentoni.
Services/Gesta.	1.7	2.9	1.7
Total born/litter	7.9	6.3	6.8
Litter size 21 d	7.4	4.3	5.8
Litter Weight 21d	1928 g	1030 g	1457 g
% Still born	1.8%	16.0%	7.3%
% Mortal. O-21d	3.7%	19.1%	7.9%

From Meshreky et al. 2007 . 3rd Parity

Bentonite as DETOXIFICATION AGENT

- Bentonite addition in the diet may alleviate, even suppress, the negative effects of mycotoxins, like aflatoxins
- The same positive effect can be used to treat some other pollutants like organophosphate insecticides

BUT

- Bentonite adsorb medicines added in the diet, making them ineffective, particularly some coccidiostats like Robenidine

Thanks
for your attention