EFFICACY OF AN INNOVATIVE PRODUCT BASED ON ZEOLITE IN THE PREVENTION OF PARTURIENT PARESIS IN DAIRY CATTLE

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Abstract

The purpose of this paper was to develop a versatile and easily applicable product for dairy cows, based on zeolite (Zeolites Development SRL, Rupea, Romania), for the prevention of hypocalcemic parturient paresis. The study was performed in an intensive dairy farm, on a total of 180 Holstein cows, 5 to 7 years of age, with an average milk production of over 8000 liters/lactation. Two zeolite porosities (P1=0.4 nm and P2=0.6 nm), two doses of zeolite (D1=25 g/kg forage, D2=10 g/kg forage) and two time intervals for administration (T1=starting 2 weeks before parturition and continuing for 60 days after parturition, T2=starting 2 months before parturition and continuing for 60 days after parturition) were tested, in all possible combinations. Blood tests were performed before the beginning of the experiment, one week before parturition, the day of parturition (onset of lactation), 48 hours and 7 days later, as well as in peak lactation, approximately 2 months after parturition. Administration of zeolite had a positive effect on all dairy cow groups, regarding their health status, parturient paresis prevention and fluctuation of blood biochemical parameters. The incidence of parturient paresis decreased more or less significantly in the experimental groups, as compared to the control group, which also corelated with the results of blood biochemistry. The average calcium blood level was normal in all groups before the beginning of the experiments and showed a tendency to decrease at the time of parturition. The decrease was higher in the control group as compared to the experimental groups, which was confirmed by the highest number of clinical cases of parturient paresis for this group. Two months after parturition, the calcium blood level was restored to normal in all cows. The recommended administration protocol for parturient paresis prevention is 20 g zeolite (0.4-0.6 nm porosity)/kg forage, starting two weeks before parturition and continuing until 60 days after parturition.

Key words*: zeolite, parturient paresis, cows, prevention*

Introduction

By the nature of their creation, zeolites are of many types, but the one that is exploited to the maximum is the clinoptilolithic zeolite due to its special properties as well as its specific physicochemical characteristics. Zeolite can be regarded as an ecosanogenic product, a natural compound, without chemicals or other additives. The chemical composition and properties of zeolite which is extracted from a rock complex in the Perşani Mountains has been studied and is very well known [9]. Previous studies have shown that zeolites have the ability to produce ion-exchanges with a beneficial effect on animals, increases the daily average gain and reduces specific consumption, stimulates the immune system, has a general antitoxic action on the gastrointestinal complex , blocks mycotoxins in feed, largely blocks radioactive substances, favors growth and development processes, substantially increases animal production and quality, increases consistency of feces, and does not pollute the environment by manure, has favorable effects in the higher conversion of feed, increases the appetite and liveliness of animals [5,6,7,8,10,11]. According to an EFSA (European Food Safety Authority) study in 2007, zeolite-based additives have been declared safe for final consumers of meat, milk or eggs from animals that received zeolite in feed or litter [12]. Clinoptilolite zeolite is registered in the European Community as a feed additive under DIN 53770 and US 21 CFRCH.I § 182 Subpart C. Also, the National Institute of Chemical-Pharmaceutical Research and Development, Bucharest, issued a toxicity test report in 2017, concluding that zeolite does not produce lethality or toxic effects and is considered as

"unclassified" according to OECD 420. The chemical composition recommends it as extremely rich in macro- and microelements with a high content of calcium oxides, potassium, iron, magnesium, sodium, etc. [9].

Therefore, the idea of using this product as a feed additive in dairy cows has arisen in order to prevent one of the most common dysmineraloses found in this category of animals, namely hypocalcemic parturient paresis (HPP), which produces significant economic loses, by decreasing milk production and inducing complications in the genital area related to uterine atony, and sometimes mortality.

HPP occurs after parturition in dairy cows due to the onset of lactation and the loss of a large amount of calcium through milk. If this loss is not compensated by nutritional intake, serum calcium decreases to values below 7 mg/dl, from normal levels of 11-12 mg/dl, sometimes even 2-3 mg/dl [2]. At the time of initiation of hypocalcaemia, it is initially subclinical, the only clinical signs being decrease of appetite and milk production; later, the clinical form consists of paralysis, initially in the hindquarters, decumbency, gastrointestinal stasis, appetite loss and abortions, cessation of milk secretion, and, in the absence of intensive parenteral calcium therapy, coma and death. During the course of the disease, complications may arise due to the cows falling down when the paralysis is established (fractures, desmorexia, tendinous and ligamentous ruptures, etc.), digestive stasis (acute ruminal tympany), uterine atony (uterine prolapse, acute or chronic endometritis) that reduce the economic value of the cow or sometimes lead to its death [4]. Therefore, HPP is a disease that produces significant economic losses and which, although well-known and described in detail for a very long time, continues to show an increased frequency in dairy cows, which demonstrates that the prophylactic means existing at today are not effective enough or not always available to farmers (they are difficult to administer), with the need for a simple and effective feed product to reduce the incidence of this dymineralosis. Thus, the purpose of this paper was to develop a versatile and easily applicable product for dairy cows, based on zeolite, for the prevention of hypocalcemic parturient paresis.

Materials and methods

The study was performed in an intensive dairy farm, on a total of 180 Holstein cows, 5 to 7 years of age, with an average milk production of over 8000 liters/lactation. Before the onset of the study, the frequency of hypocalcemic parturient paresis in this farm was of approximately 28%, and the subsequent economic losses were significant. Throughout the experiment, all cows received the same food ratio, based on corn silage, and water from the same source, ad libitum. The zeolite product used in this experiment was obtained from Zeolites Development SRL, Rupea, Romania.

Two zeolite porosities (P1=0.4 nm and P2=0.6 nm), two doses of zeolite (D1=25 g/kg forage, D2=10 g/kg forage) and two time intervals for administration (T1=starting 2 weeks before parturition and continuing for 60 days after parturition, T2=starting 2 months before parturition and continuing for 60 days after parturition) were tested, in all possible combinations. Thus, 9 groups of late pregnant cows were formed (n=20), and zeolite administration was performed as follows:

Group 1 – control, no zeolite
Group 2 – zeolite P1, D1, T1
Group 3 – zeolite P2, D1, T1
Group 4 – zeolite P1, D1, T2
Group 5 – zeolite, P2, D1, T2
Group 6 – zeolite, P1, D2, T1

Group 7 – zeolite, P2, D2, T1
Group 8 – zeolite, P1, D2, T2
Group 9 – zeolite, P2, D2, T2

Blood tests were performed before the beginning of the experiment, one week before parturition, the day of parturition (onset of lactation), 48 hours and 7 days later, as well as in peak lactation, approximately 2 months after parturition. Calcium, magnesium, phosphorus, total protein, albumin, glucose, non-esterified fatty acids (NEFA), and triglycerides serum levels were assessed. The health status of animals in all groups was permanently monitored, including the dry period, parturition, post-partum interval and udder condition.

Results

Administration of zeolite had a positive effect on all dairy cow groups, regarding their health status, parturient paresis prevention and fluctuation of blood biochemical parameters.

From a clinical point of view, the incidence of parturient paresis decreased more or less significantly in the experimental groups, as compared to the control group. The most significant impact was noticed in groups 2 and 3, in which no clinical case of parturient paresis was diagnosed (fig.1).

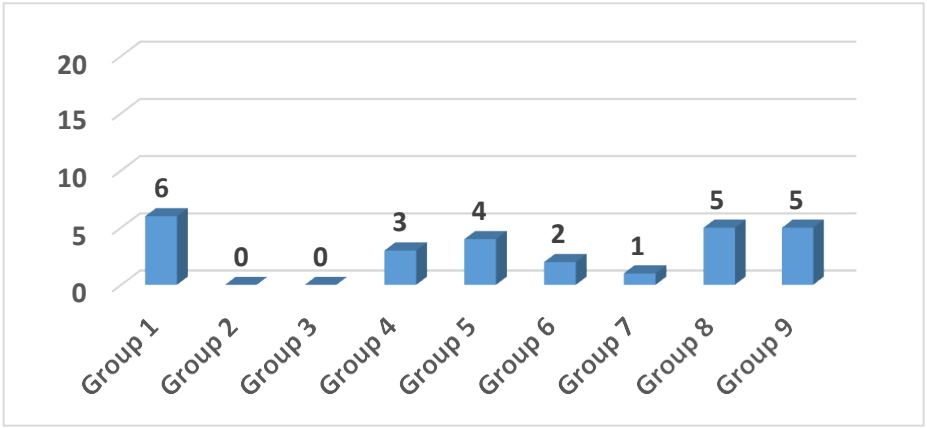

Fig. 1 Number of parturient paresis cases diagnosed in each group

Regarding other type of pathologies, 4 cases of dystocia were diagnosed, as follows:

- 2 cases in group 1, one due to fetal malpresentation and one due to insufficient uterine contractions. The latter also turned into a case of parturient paresis and was complicated by endometritis.
- 1 in group 8, due to insufficient pelvic dilation;
- 1 in group 9, due to lack of uterine contractions.

No clinical ketosis was diagnosed, nor abomasal displacement. Five of the cows developed subclinical mastitis which was diagnosed and treated immediately, with no subsequent consequences on milk production.

These results clearly show that the dominant pathology around the time of parturition was parturient paresis, with 26 clinical cases diagnosed among the 180 animals. The overall incidence during the experiment was significantly lower (14.44%) as compared to the usual 28%. Nevertheless, the incidence in the control group was 30%, which was within the normal limits of

the farm, while the experimental groups, which received zeolite supplementation, had a much lower incidence (12.5% overall), but up to 0% in group 2 and 3.

Regarding the 3 parameters that were tested (porosity, dose and time interval), there are some interesting facts that were noticed. The most significant influence was played by the moment when zeolite administration was initiated. The early administration (2 months before parturition) was not very beneficial for preventing parturient paresis, and the number of cases was only slightly lower. This is probably due to an excessive calcium intake during the dry period, when the needs are lower, leading to a deterioration of the mechanisms that restore calcemia once a large amount of calcium is lost through milk (bone resorption, etc.). Zeolite porosity did not seem to affect the results. The amount of zeolite that was administered did affect the results to a certain degree, the best results being with the higher dose (20 g/kg forage).

Therefore, the optimum protocol for zeolite administration for the prevention of parturient paresis in dairy cows turned out to be 20 g zeolite/kg forage, starting 2 weeks before parturition and continuing for at least 60 days post-partum, while the particles should have a porosity between 0.4-0.6 nm.

The blood biochemistry results are presented in table 1, as means ± SD and tend to confirm the clinical findings for each group.

The average calcium blood level was normal in all groups before the beginning of the experiments and showed a tendency to decrease at the time of parturition. The decrease was higher in the control group as compared to the experimental groups, which was confirmed by the highest number of clinical cases of parturient paresis for this group.

In groups 2 and 3, the calcium blood level decrease was the least significant due to the correct zeolite supplementation, which was also confirmed by the absence of any clinical sign of parturient paresis. In the other experimental groups, the average calcium blood level was also higher than in the control group, which lead to a lower number of parturient paresis clinical cases. Two months after parturition, the calcium blood level was restored to normal in all cows.

Magnesium and phosphorus blood level did not seem to be influenced by zeolite administration, as there was no significant difference between the blood level of this minerals in the control group and experimental groups.

The level of glycemia was within normal levels in all cows belonging to the experimental groups. All individuals recorded a slight decrease of glycemia around the time of parturition, but still within normal limits, with a slight increase later on during the lactation period.

The level of total proteins and albumins was also within normal levels for all cows, with very little variation around the time of parturition, and without a clear trend or tendency that could be observed.

In what the lipid metabolism is concerned, the level of non-esterified fatty acids (NEFA) had a normal value before the beginning of the experiment and showed an abrupt increase around the time of parturition, with a subsequent decrease close to the initial values 2 months after parturition. The behavior of this blood parameter was normal, such tendency being described also by other authors [1]. The same tendency was observed for triglycerides, which showed an obvious increase around the time of parturition in all groups, with a return to normal 2 months after calving, as shown by other authors [3].

Thus, this study clearly proves the benefits of zeolite supplementation of cow forage for the prevention of milk fever in dairy cows. This benefit as well as other positive effects of zeolite on cow's health, like food intake, digestion, ruminal fermentation, lactational performance, chemical composition of milk and udder health, was also presented by other research groups [5,6,7,8,10,11].

Although not clearly proven yet, zeolite seems to have a positive effect on the reproductive activity, at least by increasing the uterine tone (due to its high calcium level) and therefore preventing post-partum uterine inertia and further complications, like uterine infections.

No case of retained fetal membranes was observed in any of the experimental group, and this could also be linked to the same effect, although not necessarily.

Table 1

Blood biochemistry results in the 9 batches (presented as mean ± SD)

	Ca (mg/dL)	Mg (mg/dL)	P (mg/dL)	PROT (g/L)	ALB (g/L)	GLU (mg/dL)	NEFA (mEq/L)	TRY (mg/dL)
Group 1								
Before experiment	9.62±0.4	2.26±0.2	5.57±0.9	86±6.7	38±2.7	61±5.9	0.18±0.07	22.38±3.52
1 week before parturition	9.37±0.6	2.29±0.1	5.34±0.8	85±6.8	37±2.4	63±6.3	0.35±0.1	36.75±15.7
Day of parturition	7.89±2.4	2.13±0.2	5.39±0.7	82±5.9	36±3.5	53±7.4	1.59±0.12	32.89±8.36
48h after parturition	7.69±1.3	2.18±0.3	5.42±0.7	83±7.3	38±2.6	57±7.3	0.68±0.14	33.92±7.92
7 days after parturition	8.14±0.9	2.21±0.1	5.37±0.6	86±6.1	37±2.9	59±4.9	0.47±0.09	25.39±6.29
2 months after parturition	9.57±0.6	2.19±0.2	5.48±0.8	81±8.3	38±1.9	63±6.5	0.19±0.04	19.63±7.78
Group 2								
Before experiment	9.72±0.3	2.14±0.1	5.47±0.8	84±6.4	36±2.4	66±6.8	0.19±0.08	25.74±8.64
1 week before parturition	9.48±0.5	2.24±0.1	5.46±0.7	86±5.9	36±2.8	64±7.3	0.47±0.18	39.54±9.63
Day of parturition	9.16±0.7	2.12±0.3	5.42±0.9	89±6.9	38±2.7	54±8.3	1.46±0.17	36.46±8.03
48h after parturition	8.42±0.8	2.15±0.2	5.28±0.6	84±4.3	35±3.1	57±6.9	0.72±0.09	29.92±9.73
7 days after parturition	8.79±0.4	2.24±0.3	5.39±0.7	81±6.7	32±1.9	59±6.1	0.52±0.11	27.70±9.29
2 months after parturition	9.58±0.2	2.27±0.3	5.59±0.4	88±7.3	35±2.6	63±8.6	0.17±0.07	18.74±5.09
Group 3								
Before experiment	9.86±0.4	2.22±0.3	5.37±0.6	82±5.9	33±2.6	67±5.3	0.18±0.02	24.94±7.83
1 week before parturition	9.51±0.3	2.24±0.2	5.34±0.8	84±9.2	34±2.5	65±8.4	0.82±0.13	35.02±6.93
Day of parturition	9.05±0.7	2.15±0.1	5.32±0.6	81±6.2	32±2.9	57±9.5	1.82±0.17	33.84±7.89
48h after parturition	8.73±0.6	2.14±0.2	5.38±0.8	87±5.5	35±2.6	56±7.4	1.42±0.12	29.84±8.37
7 days after parturition	9.12±0.4	2.23±0.1	5.44±0.5	85±9.3	34±2.7	61±6.9	0.63±0.08	27.83±8.64
2 months after parturition	9.29±0.5	2.28±0.2	5.52±0.7	89±8.2	35±2.0	65±5.9	0.16±0.04	18.83±6.74
Group 4								
Before experiment	9.45±0.3	2.23±0.1	5.44±0.9	87±7.2	35±2.6	65±7.6	0.19±0.05	22.96±8.48

1 week before parturition	9.19±0.4	2.17±0.3	5.42±0.8	85±8.3	33±2.8	63±6.2	0.73±0.11	34.53±8.63
Day of parturition	8.28±0.8	2.16±0.2	5.32±0.6	89±4.9	36±2.9	54±8.9	1.73±0.17	32.92±7.36
48h after parturition	8.16±0.9	2.21±0.3	5.33±0.8	88±6.1	36±2.5	56±8.9	1.48±0.12	31.93±9.70
7 days after parturition	8.37±0.5	2.15±0.1	5.41±0.9	87±6.9	35±2.9	60±6.4	0.87±0.08	27.46±2.93
2 months after parturition	9.18±0.4	2.22±0.1	5.42±0.7	89±9.2	36±2.7	67±5.8	0.2±0.05	19.84±4.84
Group 5								
Before experiment	9.69±0.6	2.20±0.3	5.36±1.0	83±6.6	34±2.7	68±6.4	0.21±0.02	21.84±7.98
1 week before parturition	9.45±0.3	2.21±0.1	5.48±0.9	87±6.9	35±2.3	63±5.9	0.97±0.07	35.73±7.53
Day of parturition	8.12±0.7	2.12±0.1	5.42±0.6	85±9.4	33±2.1	57±5.8	1.84±0.17	34.87±5.83
48h after parturition	7.92±0.9	2.15±0.1	5.24±0.6	84±9.3	34±2.6	58±8.5	1.37±0.19	26.87±8.54
7 days after parturition	8.34±0.6	2.26±0.2	5.38±0.9	86±7.6	35±2.5	64±5.9	0.53±0.12	24.76±9.53
2 months after parturition	9.20±0.3	2.24±0.2	5.49±0.6	85±6.4	34±2.9	66±6.8	0.19±0.06	17.43±9.43
Group 6								
Before experiment	9.65±0.3	2.25±0.3	5.56±0.8	86±7.9	35±2.6	67±7.4	0.2±0.02	19.64±7.46
1 week before parturition	9.44±0.4	2.27±0.1	5.48±0.9	84±8.4	34±2.0	66±7.9	0.78±0.16	33.68±8.43
Day of parturition	9.09±0.8	2.18±0.3	5.39±0.5	82±9.3	33±2.5	54±7.2	1.73±0.17	31.63±9.53
48h after parturition	8.42±1.7	2.16±0.1	5.29±0.7	86±8.5	34±2.3	57±5.9	1.12±0.11	27.45±8.52
7 days after parturition	8.38±0.4	2.24±0.2	5.38±0.7	89±6.5	36±2.5	62±6.6	0.79±0.19	25.67±9.24
2 months after parturition	9.16±0.3	2.24±0.1	5.43±0.8	88±7.4	35±2.1	63±7.8	0.18±0.08	18.74±4.47
Group 7								
Before experiment	9.60±0.4	2.23±0.4	5.48±0.9	84±8.5	33±2.9	64±7.4	0.18±0.07	21.65±8.54
1 week before parturition	9.51±0.5	2.19±0.2	5.43±0.8	82±6.3	33±2.6	63±5.2	0.63±0.09	31.84±7.46
Day of parturition	9.26±1.2	2.15±0.2	5.39±0.4	88±9.1	35±2.8	54±6.4	1.63±0.17	33.64±7.59
48h after parturition	8.42±0.8	2.21±0.3	5.20±0.8	87±8.4	34±2.5	58±5.9	1.19±0.12	28.64±2.46
7 days after parturition	8.12±0.3	2.22±0.1	5.39±0.9	86±7.3	35±2.2	62±8.7	0.70±0.08	24.87±4.64
2 months after parturition	9.45±0.4	2.25±0.2	5.44±0.8	85±7.7	32±2.7	66±6.2	0.19±0.06	18.03±6.78
Group 8								
Before experiment	9.22±0.5	2.26±0.3	5.39±0.7	88±6.2	35±2.8	64±7.1	0.18±0.04	19.64±4.74
1 week before parturition	9.14±0.5	2.24±0.2	5.42±0.8	87±6.5	35±2.4	63±5.8	0.72±0.08	36.64±7.46

Day of parturition	7.71±2.0	2.16±0.2	5.33±0.7	86±6.3	34±2.5	55±7.4	1.97±0.07	33.74±7.39
48h after parturition	7.79±1.4	2.19±0.1	5.32±0.7	85±7.8	33±2.8	59±5.2	1.72±0.12	28.74±9.74
7 days after parturition	8.31±0.8	2.15±0.2	5.49±0.6	87±8.3	34±2.5	61±7.5	0.77±0.15	26.84±4.48
2 months after parturition	9.47±0.4	2.22±0.1	5.59±0.6	85±8.2	33±2.1	66±5.9	0.2±0.08	17.48±7.47
Group 9								
Before experiment	9.38±0.4	2.29±0.1	5.52±0.6	82±9.3	32±2.6	69±3.8	0.19±0.03	18.75±5.57
1 week before parturition	9.27±0.7	2.22±0.2	5.48±0.9	83±7.3	33±2.9	67±5.9	0.28±0.09	35.65±8.77
Day of parturition	7.88±2.3	2.16±0.3	5.37±0.9	88±5.3	35±2.3	56±4.8	0.96±0.18	32.75±4.75
48h after parturition	7.82±0.9	2.17±0.4	5.37±0.6	87±8.3	34±2.9	55±6.9	0.66±0.20	26.75±7.64
7 days after parturition	8.27±1.0	2.27±0.3	5.43±0.9	88±5.6	34±2.8	59±8.9	0.62±0.09	22.75±9.76
2 months after parturition	9.68±0.5	2.31±0.2	5.48±0.7	86±6.2	33±2.1	63±7.6	0.22±0.08	17.68±6.56

Ca=calcium, Mg=magnesium, P=phosphorus, PROT=total proteins, ALB=albumins, GLU=glucose, NEFA=non-esterified fatty acids, TRY=triglycerides.

Conclusion

Administration of zeolite had a positive effect on all dairy cow groups, regarding their health status, parturient paresis prevention and fluctuation of blood biochemical parameters. The recommended administration protocol for parturient paresis prevention is 20 g zeolite (0.4-0.6 nm porosity)/kg forage, starting two weeks before parturition and continuing until 60 days after parturition.

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