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## The efficacy of kaolin clay in reducing the duration and severity of ‘heat’ diarrhea in foals

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**Abstract:** ‘Heat’ diarrhea in foals is an onerous but not life-threatening ailment, which indicates that it may be of osmotic origin. This was confirmed by a successful attempt, presented in this paper, to alleviate the severity and duration of foal heat diarrhea with the use of a typical absorbent, kaolin clay, as a feed additive, usually applied in feed production as an anticaking agent. Based on the present results, it can be concluded that treatment of foals maintained on different stud farms with a kaolin paste reduced the duration of heat diarrhea and alleviated its severity ( $P < 0.05$  and  $P = 0.001$ ). The observed action of kaolin clay, an excellent absorbent, suggests that the so-called heat diarrhea can be caused by disturbances in the intestinal osmotic balance at this specific age of foals. The use of this preparation can reduce the risk of secondary pathological viral or bacterial diarrhea and the requirement for veterinary intervention in foal management. It can also shorten the care period and increase foal well-being, essential for the normal development of a young horse. In addition, prophylactic application of an antidiarrheal preparation based on an industrial by-product, i.e. a cheap component, will reduce the costs of foal care.

**Key words:** Horse, foals, heat diarrhea, kaolin clay

### 1. Introduction

The first diarrhea in foals is very often called ‘heat’ diarrhea because it coincides with the first postfoaling heat in the dam, i.e. at 7–9 days after foaling (1), and it is most often treated as a physiological phenomenon, though it is onerous for hygienic reasons. In spite of many studies (2–4), the etiology of this ailment has not been unequivocally explained. Until recently, a majority of gastrointestinal disturbances were treated with different antibiotics. Once the use of antibiotics as feed supplements for domestic animals was limited, there was a need for the search for substitutes, like prebiotics, probiotics, synbiotics, and nutraceuticals (5). Kaolinite ( $\text{Al}_4[\text{Si}_4\text{O}_{10}][\text{OH}]_8$ ) is one of these as an excellent absorbent. Owing to its adsorptive properties, kaolin clay finds applications as anticaking supplement E559 (EFSA, European Food Safety Authority) mixed with feed (6). It can also be an additional source of minerals, mostly iron, in feed. It would be useful both for breeders and veterinarians to establish whether reduction of fluid level in the intestines with kaolin clay given orally as a feed additive would be helpful to alleviate heat diarrhea, especially underlain by osmotic disturbances. Therefore, the main aim of the present study was to determine the effect of kaolin clay on the duration and severity of ‘heat’ diarrhea in foals.

### 2. Materials and methods

The experiment was conducted in Poland at two stud farms of purebred Arabian horses (oo) designated as A and C and two stud farms of Thoroughbred horses (xx) designated as B and D. The examined horses were housed in a housing-pasture system on straw bedding. Dams were fed oats and barley grain, wheat bran, and meadow hay, according to 1997 Polish Requirements of Horse Nutrition. All studied foals were born from January to March, with a total of 76 foals, and were evaluated for incidence of diarrhea. Sixty foals that showed symptoms of diarrhea up to 30 days postfoaling were included in the study. The studied suckling foals were assigned to two groups: control (Con.) and experimental (Exp.). Each experimental foal was given orally once a day (at 0700 hours), using a special syringe, 15 mL of kaolin clay paste (75% dry matter) beginning on the first day of diarrhea for 3 subsequent days. Throughout the study, the health of all animals was thoroughly evaluated by experienced workers, especially on the first day of ‘heat’ diarrhea, and its duration and severity were recorded. In all suckling foals, diarrhea severity was scored on a 3-point scale: 1- mild diarrhea, i.e. when perianal area, croup, and tail were only damp; 2- moderate diarrhea, i.e. when perianal area, croup, and tail were wet, with fecal staining

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and with damp patches of watery feces on the thighs; and 3- severe diarrhea when perianal area, croup, and tail were very wet, with very heavy fecal staining and with patches of watery foamy feces on the thighs and below, with stains also seen on stall walls or on the dam.

To confirm the working hypothesis, the obtained data were subjected to statistical analysis: discrete variables (diarrhea duration expressed exactly to 1 day) were analyzed for the type of distribution and were demonstrated to obey a Poisson distribution. Therefore, a general linearized model for such data was applied to assess the effect of group (experimental/control), stud farm, and sex. Qualitative data (diarrhea severity scored on a 3-point scale) were analyzed using the chi-square test.

The study was carried out using preparation E559 (POLFEED Sp. z o. o., Krakow, Poland). In conformity with *Dziennik Ustaw of 22 February 2013, item 253* and *Commission Regulation No. UE 744/2012*, it was demonstrated that the contents of dioxins and polychlorinated biphenyls and asbestos and toxic metals (lead, arsenic) did not exceed regulatory standards.

### 3. Results

In all animals participating in the study, vital signs and health indicators (behavior, body temperature, heart rate, respiratory rate) were within the physiological range for foals of that age. Evaluation of foals born from January

to March 2014 for incidence of diarrhea demonstrated that almost 80% of all suckling foals showed diarrhea symptoms within the first month of their life. No significant differences in diarrhea incidence were observed between different stud farms or between purebred Arabian and Thoroughbred foals. The greatest diarrhea incidence was observed in stud farm D breeding Thoroughbred horses (86.7%) and stud farm A purebred Arabian horses (84.6%) (Table 1). The first signs of diarrhea were observed in the study group of foals in an average of 11 days after foaling. At the earliest they were seen in purebred Arabian foals of stud farm A and in stud farm D breeding Thoroughbreds; at the latest, at 13.2 days after foaling, diarrhea was recorded in Thoroughbred foals from stud farm C, where the largest variability of data was also noted (Table 2). Kaolin clay treatment was demonstrated to significantly influence the duration of the first heat diarrhea in foals (Table 3). The mean diarrhea duration in foals treated with preparation E559 from the first day when diarrhea signs were noticed was significantly shorter (by 1 day) compared to the respective value in the control group untreated with the preparation (Table 3). As regards the place of birth, diarrhea in experimental kaolin preparation-treated foals was shorter in stud farms B, C, and D versus untreated foals. For stud farm A, the relationship was opposite. However, these differences were not statistically significant (Table 4). The studies showed that in the experimental group, the

**Table 1.** The number of foals with and without diarrhea symptoms observed at each stud farm.

Stud	Breed	n	Number of foals without diarrhea	Number of foals with diarrhea symptoms	% of foals with diarrhea symptoms
A	oo	13	2	11	84.6
C	oo	22	6	16	72.7
B	xx	26	6	20	76.9
D	xx	15	2	13	86.7
Total		76	16	60	78.9

**Table 2.** The term of diarrhea occurrence in observed foals at each stud farm (day after birth).

Stud	Breed	n	Mean	SD	Min/max
A	oo	11	9.36	2.83	6/17
C	oo	16	10.62	4.11	7/21
B	xx	20	13.20	7.39	3/28
D	xx	13	9.61	2.36	6/14
Total		60	11.03	5.2	3/28

**Table 3.** The average duration of diarrhea (days) in control and experimental foals.

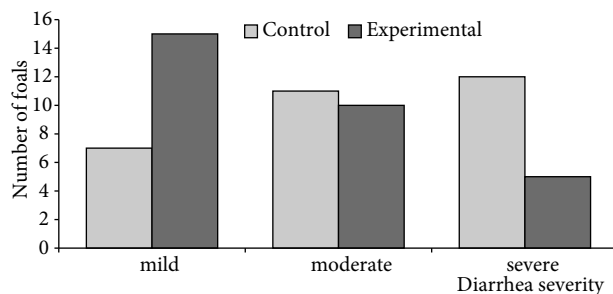
Group	n	Mean	SD	Min/max
Con.	30	4.30 <sup>b</sup>	1.64	1/8
Exp.	30	3.26 <sup>a</sup>	1.74	1/7
Total	60	3.78	1.67	1/8

<sup>a,b</sup> – means within a column with different superscripts are different ( $P < 0.05$ ).

**Table 4.** The duration of diarrhea (days) in studied foals born on different stud farms.

Stud	Group	n	Mean $\pm$ SD for group	Min./max.
A	Exp.	5	5.40 $\pm$ 1.67	3/7
	Con.	6	4.00 $\pm$ 0.89	3/5
B	Exp.	14	2.42 $\pm$ 1.01	1/5
	Con.	6	2.83 $\pm$ 0.75	2/4
C	Exp.	5	3.60 $\pm$ 1.67	2/6
	Con.	11	5.27 $\pm$ 1.27	4/8
D	Exp.	6	3.17 $\pm$ 1.94	1/6
	Con.	7	4.29 $\pm$ 1.78	1/8

number of foals with more severe diarrhea decreased. The number of experimental foals affected by mild diarrhea (15 foals) was statistically significantly greater than the number of foals with severe diarrhea (5 foals) ( $\chi^2 = 14.17$ ;  $P = 0.001$ ) (Figure). The relationship in the control group untreated with the kaolin-based preparation was entirely opposite. Only 7 foals showed signs of mild diarrhea, while as many as 12 foals experienced severe diarrhea (Figure). Additional statistical analysis indicated that sex did not significantly influence the severity of diarrhea. Due to too few observations in diarrhea severity classes for individual



**Figure.** The number of foals in control and experimental groups assigned to classes based on diarrhea severity scores (1, 2, or 3 points).

farms, it was not possible to unequivocally determine whether stud farm had any effect on diarrhea severity in foals.

#### 4. Discussion

The aim of the present study was to establish whether a kaolin-based preparation can alleviate symptoms of the first heat diarrhea in foals. In terms of composition, kaolin clay, which accompanies coal deposits, is similar to forest soils rich in alumina-silicates. After drying and grinding, it has a loose porous texture and thus it is capable of absorption of vapors, gases, water, and soluble substances (7). Porosity of kaolin clay used in the present studies was confirmed by physicochemical studies suggesting that, besides silica gel, it is the most powerful natural absorbent. It is also an excellent example of a molecular sieve able to absorb on its surface molecules of chemical compounds (6). Small pores and high cation exchange capacity (CEC) unequivocally indicate excellent absorptive properties of this substance (7). The present studies demonstrated a beneficial effect of the kaolin-based preparation administered during the first three days of diarrhea. It was proven that diarrhea was significantly shorter by more than 1 day in experimental suckling foals treated with the preparation compared with the untreated control group. Analysis of the severity of

heat diarrhea scored in all foals under study on a 3-point scale demonstrated that a majority of experimental foals presented signs of mild or moderate diarrhea. Severe diarrhea with foamy feces staining the croup area and hind legs even below the ankle joints was observed in only 17.3% of experimental foals. Animals suffering from such severe diarrhea require additional time-consuming care involving repeated washing of the affected areas with warm water, drying, and often application of appropriate cream or jelly. Otherwise, diarrhea can cause scalding and hard-to-heal wounds (8). The growth rate and health of young horses depend on many factors (9). The nutritional status of young organisms evaluated based on body condition depends mostly on intake of nutrients and individual ability to absorb them. Digestion and absorption of nutrients should not be hindered or impaired; however, it can happen that different factors can seriously hamper them. Diarrhea of different origin is one such factor disturbing those processes in the digestive tract. Diarrhea is particularly dangerous in very young foals when the dam's milk is their main feed, i.e. within the first 5–8 months of their life (10). Johnston et al. (11) and Deskur et al. (12) did not find a relationship between the contents of basic milk components (fat, protein, and lactose) and the incidence and severity of diarrhea in suckling foals. According to Masri et al. (2), Magdesian (13), and Mallicote et al. (8), the factors predisposing to heat diarrhea include immaturity of the intestinal wall, hypersecretion of intestinal mucus, or adaptive changes in intestinal bacterial flora. Roberts et al. (14) and Wesse et al. (15) suggested that diarrhea in foals may be caused by primary or secondary lactose intolerance. However, the most probable cause is that food-related agents or gut properties decreasing water absorption from the intestines could increase the vulnerability of animals to this disorder, leading to osmotic diarrhea (16). Osmotic diarrhea can also be caused by excess of short-chain fatty acids derived from bacterial flora of the large intestine. Studies by Sgorbini et al. (17) and Harris et al. (18) virtually excluded the possibility that parasitic infections could be the cause of the first diarrhea after birth in foals. The main pathogens that may cause transformation of nonpathogenic (heat) diarrhea into pathogenic diarrhea include *Salmonella* sp.; *Escherichia coli*; *Lawsonia* sp.; *Clostridium* spp., mostly *difficile* and *perfringens*; and *Bacteroides* (19–23), rotavirus and coronavirus (24–26), internal parasites (18,24,26,27), and yeast (17,28). Apart from posing a risk to health, diarrhea is also onerous for sanitary reasons. Veterinary procedures essential in treating diarrhea, like drug administration often via a gastric tube or intravenous electrolyte replacement, are time-consuming and require appropriate procedures, which increases the cost of foal care. Therefore, a breeder should have some knowledge of

the symptoms of diarrhea to be able to make a decision about when diarrhea may be hazardous to the health or even life-threatening for a foal and whether veterinary intervention is required (8). Analyses carried out in the present study demonstrated that of 76 evaluated foals a little more than 20% (16 foals) presented no signs of diarrhea within 30 days after foaling. This result is similar to those reported by Masri et al. (2), who investigated symptoms of diarrhea, including heat diarrhea, in foals of different breeds. On the other hand, Sgorbini et al. (17), like Ferrari et al. (29), observed heat diarrhea in 49% of suckling foals evaluated for the effect of yeasts on diarrhea incidence within the first month of age. On the contrary, Perucci et al. (27) noted diarrhea only in 24% of foals evaluated for *Cryptosporidium parvum* infection. Berger et al. (30) observed diarrhea in 74% of suckling foals born to dams untreated with a probiotic supplement and in 43% of foals when dams received a prior treatment with the probiotic Vivaflor containing inactivated bacteria *Lactobacillus* sp. and *Propionibacterium*.

The results of the present study indicate that the mean duration of the first so-called heat diarrhea in all foals under study did not exceed an average of 4 days, ranging from only 1 day to 8 days. Pieszka and Kulisa (3,10) observed diarrhea lasting an average of 3–5 days in purebred Arabian suckling foals while Masri et al. (2) and Perucci et al. (27) reported that the duration of the first heat diarrhea was 3–4 days and thereafter the symptoms disappeared. A comprehensive analysis of the influence of preparation E559 on heat diarrhea in foals, carried out in the present study, demonstrated a beneficial effect of kaolin clay, manifested by shortened diarrhea duration and alleviated severity. This effect, most probably connected with high cation exchange capacity of kaolin clay, may suggest that heat diarrhea in foals occurring in the second week of their life is underlain by disturbances in the intestinal osmotic balance of young horses. Foals treated with kaolin clay showed shorter diarrhea episodes and lower incidence of moderate and severe symptoms compared to E559-untreated foals, which more often suffered severe diarrhea with excretion of foamy, foul-smelling feces. However, none of the studied foals required veterinary intervention, and none had secondary skin damage or hard-to-heal wounds of the croup or hind legs. To our best knowledge, there are no literature data on the effect of absorbents, including kaolin clay, on the duration and severity of diarrhea scored on a 3-point scale. Therefore, it seems that the problem of symptomatic treatment of osmotic diarrhea in foals using specific physicochemical properties of kaolin clay is worthy of further studies on a larger group of foals. Moreover, kaolin clay is a by-product of coal mining, which requires waste management, so it is cheap and easily available, which may reduce the cost of foal care, prophylaxis, and treatment.

It can be concluded that the treatment of foals with kaolin clay in the form of a paste at a dose of 15 mL once a day for 3 consecutive days beginning on the first day of diarrhea significantly reduced the duration and severity of heat diarrhea. The beneficial effect of kaolin clay, an excellent absorbent, observed in the present studies suggests that heat diarrhea can be caused by disturbances

in the intestinal osmotic balance. A wider use of this preparation can ameliorate the zoohygienic environment of foals, reduce the risk of secondary pathological viral or bacterial infections, and improve foal well-being, essential for propitious development of a young horse. The use of economically reasonable kaolin clay, a by-product of coal mining, can also reduce the costs of foal care.

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