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THE EFFECT OF A CLINOPTIOLITE BASED MINERAL ADSORBENT ON COLOSTRAL IMMUNOGLOBULIN G ABSORPTION IN NEWBORN PIGLETS

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The aim of this study was to estimate the influence of the presence of added natural zeolites on the degree of absorption of colostral IgG in newborn piglets. The experimental groups were fed colostrum and a mineral adsorbent preparation was given per os at a total concentration of about 5 g/l colostral intake per day divided into two of four doses.

In blood sera of the animals of experimental group I (two doses), concentrations of IgG were 39.00± 8.22 g/l and 42.10 ± 9.34 g/l respectively 24 and 48 hours after birth. In blood sera of the animals of experimental group II four doses, concentrations of IgG were 49.40 ± 7.20 g/l and 54.40± 7.80 g/l respectively 24 and 48 hours after birth. In blood sera of the control group, concentrations of IgG were 30.50± 7.90 g/l and 40.50± 9.10 g/l respectively 24 and 48 hours after birth.Piiglets in experimental group I had a 30% higher concentration of IgG than the respective control group 24 hours after birth, and the difference was statistically significant. Piglets of experimental group I also had a higher concentration of IgG than the respective control group 48 hours after birth, but the difference was not statistically significant. Piglets of experimental group II had 60% and 35% higher contrentrations of IgG than the respective control group 24 and 48 hours after birth and the differences were statistically significant.

Mean values for body weight of piglets after birth were almost equal in all groups.

The data from this investigation show that oral intake of a preparation of mineral adsorbent in concentration of about 5 g/l colostral intake per day leads to a significantly higher degree of absorption of colostral IgG in newborn piglets.

Key words: colostrum, colostral immunoglobulins, IgG immunoglobulins, newborn piglets, clinoptiolite.

INTRODUCTION

In animals with epitheliochorial types of placenta, such as a pigs, transplacentral passage of immunoglobulin molecules is totally prevented. Piglets are born with almost no serum Ig under physiological conditions and asquire passive immunity by absorbing immunoglobulins from maternal milk - colostrum. Intestinal absorption of maternal Ig (IgG; IgA;IgM) from colostrum plays a vital role during early neonatal life (Bourne and Curtis, 1973; Kumuves and Heath, 1992).

The gastrointestinal tract of newborn piglets is permeable for intact Ig ingested with colostrum (Klobasa et al., 1991). In pigs IgG predominates in colostrum and is the predominant Ig passively transferred. Since, protein absorption is selective, IgG and IgM are preferentially absorbed, while IgA mainly remains in the intestine (Porter, 1969; Butler et al., 1981). Absorption of colostral Ig occurs via pinocytosis by epithelial cells in the small intestine. Intact Ig molecules are passed through these cells into the lymphatic system and eventually enter the blood system.

The extent and duration of the passage of intact proteins has been investigated by many authors. In general, permeability of the intestinal epithelium is highest immediately after birth but, 50% lower within six hours (Vellenga et al., 1988), because the intestinal cells that absorb Ig are replaced by a more mature cell population (Tizard, 1994). Absorption of all Ig classes will drop to a relatively low level after approximately 24 hours (Tizard, 1994).

Lecce and Morgan (1962) state that intestinal absorption ceases by 24 to 36 hours after birth in the neonatal pig. Some authors found that piglets when nursed lost their capacity to absorb macromolecules within 12 to 36 hours after birth while starved piglets retaind their ability to absorb macromolecules for 72 to 106 h postpartum (Payne and Marsh, 1962; Lecce, 1973). Klobasa et al.(1991) found that the passage of intact proteins ceases between 12-18 hours after onset of feeding.(Results indicate, that the absorptive ability of the intestinal epithelia for immunoglobulins is not timed from birth but rather from the onset of feeding)

Since colostral Ig are the key factor of humoral immunity in newborn piglets and during the first few weeks of their life, many authors have sought conditions under which the degree of absorption of colostral Ig may be increased and have studied the effects of many factors on the level of absorption of colostral Ig. Thus, Kelly et al. (1982) examined the effect of the environment and stress (cold exposure) on absorption of colostral Ig in piglets. Klobasa et al. (1990) examined the effect of time from birth to the first feeding on the level of absorption of colostral Ig. Klobasa et al.(1991) investigated the influence of the duration of colostrum administration. Vellenga et al. (1988) investigated the effect of feeding 5% glucose solution or milk replacer to newborn piglets for 24 hours before they were given colostrum on intestinal permeability to macromolecules. Klobasa et al.(1991) studied the effect of fasting, water or glucose solution administration on the permeability of the newborn intestine.

The adsorption effects of mineral adsorbent based on clinoptilolite have been widely applied in domestic animals in the last few years (Tomašević-Čanović

et al. 1994, 1995; Petrović et al. 1995; Stojić et al. 1995). Stojić et al., (1995) showed that a clinoptilolite based mineral adsorbent in colostrum 5g/L leads to significantly higher absorption of colostral IgG in calves. Effects of the mineral adsorbent (Minazel) on the state of health and production result in pigs were studied by Stankov et al. (1992) and Rajić et al. (1995).

In this paper the effects of a preparation of clinoptilolite based mineral adsorbent added per os on the degree of absorption of colostral immunoglobulins G in newborn piglets at different time intervals after birth is presented.

MATERIAL AND METHODS

Animals. The experiment was carried out using a control and two experimental groups of newborn piglets.

Control group. The control group consisted of 43 piglets from 5 litters. Each piglet received 7.5 ml 0.9% saline solution orally immediately after birth prior to colostral intake at 12,24 and 36 hours after birth.

Experimental group I. Each of 44 piglets from 5 litters received 15 ml 15% suspension of mineral adsorbent orally immediately after birth prior to colostral intake and 24 hours after birth. The mineral adsorbent was approximately 5 g/l of the colostrum suckled per day).

Experimental group II. 23 piglets from 3 litters were studied. Each of 23 piglets from 3 litters received 7,5 ml 15% suspension of Minazel orally immediately after birth (before colostum intake), as well as 12,24 and 36 hours after birth.

Mineral adsorbent. The examined mineral adsorbent was obtained by technologycal preparation of the zeolite tuff from Zlatokop (South Serbia, Yugoslavia). The comercial preparation is a suspension of mineral adsorbent based on zeolite tuff (Minazel, ITNMS, Patent commerce, Belgrade, Yugoslavia) placed in the class under 6 micrometers. The examined mineral adsorbent was obtained by centrifugal classification of Minazel by centrifugation (Sharples P-600) at 1000 RPM.

The main characteristics are:

- Mean particle size of 3,8 micrometers.

No particles greater than 8 micrometers.

- The particle size distribution was determined on a Coulter Multisizer (Figure 1). It is obvious that all particles were smaller than 8 micrometers.

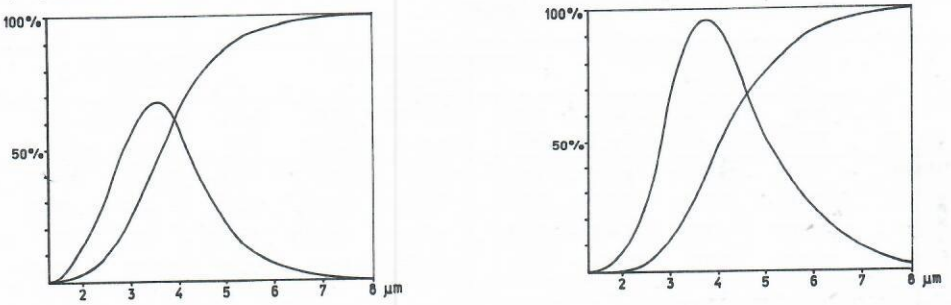

Figure 1. The particle size distribution of Minazel

- The chemical composition of Minarel is given in Table 1 as determined on an ARL 9400 X-ray Spectrometer.

Table 1. Chemical composition of the mineral adsorbent (%)

component	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	L.I.
content	66.46	12.77	2.68	0.12	3.22	1.11	0.78	1.21	9.15

The cation exchange capacity (and type of exchangeable cations) was determined by the ammonium acetate method (Table 2)

Table 2. CEC and exchangeable cations of the mineral adsorbent

exchangeable cation	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Total
CEC mmol/100g	121	25	25	2	173

Blood samples. Blood samples were taken by punction from the plexus brachiocephalicus of the piglets 24 and 48 hours after birth. After spontaneous coagulation at room temperature the serum was separated and stored in a deep freeze at - 20^{0}C until analyzed.

Immunodiffusion. Imunoglobulin G concentration in the blood sera of piglets was determined using double immunodiffusion on commercial RID plates (INEP-Zemun, Yugoslavia).

Statistical analysis. The significance of differences between groups was calculated using Students t-test.

RESULTS AND DISCUSSION

Concentrations of serum immunoglobulin G in piglets of the experimental and control groups 24 and 48 hours after birth are shown in Table 3.

Table 3. Body weight after birth and concentrations of serum immunoglobulin G in blood sera in experimental and control groups of piglets.

	Experimental group I (n = 44)			Experimental group II (n = 23)			Control group (n = 43)		
	b.w. (kg)	Ig G conc. (g/l) 24h a. b	48h a. b	b.w. (kg)	Ig G conc. (g/l) 24h a. b	48h a. b	b.w. (kg)	Ig G conc. (g/l) 24h a. b	48h a. b
Mean	1.53	39.00	42.10	1.64	49.40	54.40	1.67	30.50	40.50
SD	0.20	8.22	9.34	0.21	7.20	7.80	0.22	7.90	9.10
SE	0.03	1.25	1.42	0.04	1.50	1.66	0.03	1.22	1.41
CV%	13.10	21.10	22.20	12.4	14.20	14.00	13.2	25.90	22.50

Legends: b. w. (body weight); a. b. (after birth)

Mean IgG concentration in serum of piglets from experimental groups I and II 24 hours after birth were 39.0± 8.2 g/l and 49.4± 7.2 g/l. At the same time, in the serum of the control group it was 30.5± 7.9. It can be seen that the absorption of colostral IgG in the piglets from experimental group I was approximately 30% higher than in the controls. IgG concentration in the serum of piglets from experimental group II was 60% higher than in the control. Thus significantly higher concentrations of serum IgG were found in piglets from both experimental groups I and II compared to the control group 24 hours after birth ($p<0.001$). Our values obtained for the control group correspond to the values found by other authors (Morgan,1980; Gagrčin, 1981). On the other hand, mean serum IgG concentration in piglets from both experimental groups I and II 24 hours after birth were much higher than those of the mentioned authors. There are only a few similar results in the literature. Gagrčin (1981) found that IgG concentrations in sera of piglets from sows vaccinated against pestis suis were 39.8 ± 22.3 g/l 24 hours after birth.

Mean immunoglobulin G concentrations in the serum of piglets from experimental group I, experimental group II and the control group 48 hours after birth were 42.1 ± 9.3 g/l, 54.4 ± 7.8 g/l and 40.5 ± 9.1 g/l. The difference in mean concentration of IgG between experimental group I and the control group was not statistically significant. It can be seen that the absorption of colostral IgG in the piglets from experimental group II was approximately 35% higher than in the control, and the difference was statistically significant ($p<0.001$).

The results presented in Table 3. clearly indicate that the oral preparation of a 15% suspension of "Minazel" zeolite given in the first 36 hours after birth led to a significant increase of IgG concentrations in the blood of piglets from both experimental groups 24 and 48 hours after birth. An experiment carried out on calves showed similar results (Stojić et al. 1995). At the present moment we do not have a satisfactory explanation for this surprising phenomenon. However, since it has been shown that this mineral adsorbent efficiently binds aflatoxins B1 and G1 (Tomašević - Čanović et al. 1994), we can speculate that in conditions of high protein intake and the absence of digestive enzymes for some time after birth, it may bind some degradation products of colostral proteins in the gut, thus preventing their supposed negative effect on the mucosal epithelial cells which absorb immunoglobulin.

The low values of variance (SD, SE, CV%) for serum IgG concentration of the experimental groups indicate that the presence of mineral adsorbent in the digestive tract positively influences the absorption of colostral IgG in all cases. These data additionally support the above mentioned opinion about the possible mode of zeolite action to increase the absorption of colostral IgG.

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REFERENCES

1. *Bourne F. J., and Curtis J.* 1973. The transfer of immunoglobulins IgG, IgA, and IgM from serum to colostrum and ilk in the sow. Immunology, 24, 157.
2. *Butler J. E., Klobasa F., Werhahn E.* 1981. The differential localization of IgA, IgM and IgG in the gut of suckled neonatal piglets. *Vet. Immunol. Immunopathol, 2 (1),* 53-65.
3. *Gagrčin M.* 1981. Efekat vakcinacije gravidnih krmača na nivo imunoglobulina G u krvnom serumu novorođene prasadi. Magistarska teza. Veterinarski fakultet Beograd.
4. *Kelley K. W., Blecha F., Regnier J. A.* 1982. Cold exposure and absorption of colostral immunoglobulins by neonatal pigs. *J. Anim Sci, 55 (2),* 363-8.
5. *Klobasa F., Habe F., Werhahn E.* 1990. The absorption of colostral immunoglobulins in newborn piglets. I Effect of time from birth to the first feeding. *Berl Munch Tierarztl Wochenschr, 1990, 103:10,* 335-40.
6. *Klobasa F., Habe F., Werhahn E.* 1991. The absorption of colostral immunoglobulins in newborn piglets. II Effect of water or glucose solution on the permeability of the newborn intestine. 1991. Berl Munch Tierarztl Wochenschr, 104: 2, 37-41.
7. *Klobasa F., Habe F., Werhahn E.* 1991. The absorption of colostral immunoglobulins in newborn piglets. III Influence of the duration of colostral administration. *Berl Munch Tierarztl Wochenschr,* 1991. 104:7, 223-7.
8. *Kmuves L. G., and Heath J. P.* 1992. Uptake of maternal immunoglobulins in the enterocytes of suckling piglets: improved detection with a streptavidin-biotin bridge gold technique. *J. Histochem Cytochem, 40 (11),* 1637-46.
9. *Lecce J. G., and Morgan D. O.,* 1962. Effect of dietary regimen on cessation of intestinal absorption of large molecules (closure) in neonatal pigs and lambs. *J. Nutr. 78,* 265.
10. *Lecce J. G.* 1973. Effect of dietary regimen on cessation of uptake of macromolecules by piglet intestinal epithelium (closure) and transport into blood. *J. Nutr. 103,* 751.
11. *Morgan L. K., Hussein M. A., Newby J.T., Bourne J.F.* 1980. Quantification and origin of the immunoglobulins in porcine respiratory tract secretions. *Immunology. 40,* 3.
12. *Payne L. C., and Marash C. L.* 1962. Gammaglobulin absorption in the baby pig: the nonselective absorption of heterologus globulins and factors influencing absorption time. *J. Nutr. 76,* 151.
13. *Petrović M., Kastelan-Macan M., Kralj M.* 1995. Quantitave chromatographic analysis of aminoacids on natural zeolite thin layers. Sofia Zeolite Meeting 1995, *Intern. Symp. on Natural Zeolite, Sofia, 77.*
14. *Porter P.* 1969. Porcine colostral IgA and IgM antibodies to Escherichia coli and their intestinal absorption by the neonatal piglet. Immunology, 17,617.
15. *Rajić I., Trajković D., Tomašević-Čanović M., Dunić M., Vukićević O., Bočarov A.* 1994. Effect of Minazel added to zearalenone and ochratoxin contaminated diets of pregnant sows on the bearing results. Veterinarski glasnik, 48 (10), 881-888.
16. *Stankov M., Obradović V., Obradović J., Vukićević O.* 1992. Effects of the mineral adsorbent on state of health and production results of piglets. *Veterinarski glasnik, 46 (2),* 91-96.
17. *Stojić V., Šamanc H and Fratrić N.* 1995. The effect of a clinoptilolite based mineral adsorber on colostral immunoglobulin G absorption in newborn calves, Acta Veterinaria, 45, (2-3), 67-74.
18. *Tizard R. I.* 1996. Veterinary Immunology. *W. B. Saunders Company. Philadelphia - London - Toronto,* 238-250.
19. *Tomašević-Čanović M., Dumić M., Vukoćević O., Mašić Z., Zurovac-Kuzman O., Daković A.* 1995. The adsorption of mycotoxins on modified clinoptilolite. *Sofia Zeolite Meeting 1995, Intern. Symp. on Natural Zeolite,* 78.
20. *Tomašević-Čanović M., Dumić M., Vukočević O., Radošević P., Rajić I., and Palić T.* 1994. The absorption effects of a mineral adsorber of the clinoptilolite type part I. desorption of aflatoxins B1 and G2. *Acta Veterinaria,44, (5-6),* 309-318.
21. *Vellenga L., Wensing T., Breukink H. J.* 1988. Effect of feeding 5 per cent glucose solution or milk replacer to newborn piglets on intestinal permeability to macromolecules. *Vet. Rec. 123(15),* 395-7.

UTICAJ MINERALNOG ADSORBENTA NA BAZI KLINOPTILOLITA NA RESORPCIJU KOLOSTRALNIH IMUNOGLOBULINA G KOD NOVOROĐENE PRASADI

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SADRŽAJ

U ogledu na ukupno 67 prasadi podeljenih u dve eksperimentalne grupe sa po 44, odnosno 23 novorođena praseta ispitivan je uticaj prisustva mineralnog adsorbenta na bazi klinoptilolita, na stepen resorpcije kolostralnih imunoglobulina G. Novorođena prasad su prirodnim putem uzimala kolostrum a mineralni adsorbent u koncentraciji od 5g/l posisanog kolostruma u toku jednog dana je dodavan (per oss) 2-4 puta dnevno u jednakim vremenskim intervalima tokom prva 36 h nakon rođenja. U uzorcima krvi uzetim 24h i 48h posle rođenja otkriveno je prisustvo IgG u značajno većoj koncentraciji nego kod kontrolne grupe prasadi. Na osnovu dobijenih rezultata zaključeno je da prisustvo mineralnog adsorbenta u digestivnom traktu novorođene prasadi značajno povećava stepen resorpcije kolostralnih imunoglobulina G.