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DOI: 10.2478/fv-2022-0031

FOLIA VETERINARIA, 66, 4: 1–5, 2022

ANALYSIS OF FAECAL PH IN PIGLETS FROM BIRTH TO WEANING

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ABSTRACT

The health of the gastrointestinal system of pigs is still a topical issue. When focusing on the youngest categories of pigs, we routinely evaluate it on the basis of appetite assessment and physical examination of faeces. A piglet's gut health is also related to the development and changes of pH in the digestive system. Because there is little scientific work in this area, the aim of this study was to evaluate the physiological range of faecal pH in healthy suckling piglets from birth to weaning. Faecal pH measurements were performed in thirty-five suckling piglets at the time of the piglets' birth, on the 7th, 14th, 21st, and 28th day of their life. We found the mean pH values to be 6.38±0.46 within 24 hours after birth; 7.14±0.23 on the 7th day after birth; 7.23±0.23 on the 14th day after birth; 7.42±0.60 on the 21st day after birth; and 7.72±0.61 on the 28th day after birth. Statistical analysis showed significant differences between the pH of the faeces of new-born piglets and the samples taken in the following weeks of the experiment (P<0.05; P<0.01; P<0.001). Measuring faecal pH can be a simple, quick and inexpensive method used to determine the health status of piglets' intestines.

Key words: faeces; faecal pH; stool; suckling piglet

INTRODUCTION

The health status of the digestive system can be assessed and evaluated according to various parameters and examinations [13, 14, 23]. Faecal examination, which is a completely non-invasive approach, plays an important role here. The consistency and colour of the faeces, undigested feed ingredients, as well as mucus and blood admixtures are evaluated. In the case of a severe diarrhoea, bacteriological, parasitological or virological examination of the faecal samples is required [9].

According to various studies conducted on different species of animals and also in humans, pH measurement can be used to assess the health of the intestinal system [8, 17]. By testing stool pH in humans, a stool sample is tested for acidity to diagnose a medical condition. Acid stool may indicate a digestive problem such as: lactose intolerance, an infection such as rotavirus, or an overgrowth of acid-producing bacteria such as lactic acid bacteria. Faecal pH is also a commonly used response variable in equine nutrition studies focused on evaluating gastrointestinal health [2, 8]. Faecal pH and buffering capacity are indirect tests useful to detect hindgut changes of horses [1]. Hindgut acidosis can be problematic on many levels, as horses with this condition tend to have subclinical symptoms, such as: a take-it-or-leave attitude toward feed,

weight loss, recurrent mild colic, unusually soft manure, or behavioural changes [24].

However, to correctly read and understand faecal pH values, reference values from healthy animals without problems are needed. To date, there is very little data on faecal pH measurement in pigs [12]. There are several studies that examine pH in the intestinal tract, but not in faeces [4, 20, 21].

The aim of this study was to evaluate the physiological range of faecal pH in suckling piglets from birth to weaning.

MATERIALS AND METHODS

Animals

A range of faecal pH was determined based on the readings of 35 healthy piglets from 7 sow litters (a cross bred between Pietrain, Duroc and Landrace) at the pig clinic of the University of Veterinary Medicine and Pharmacy in Košice. Sows in the maternity ward were housed on a concrete floor with a separate and heated area for the piglets. From the first minutes after birth, the piglets had access to the sow's colostrum, later to the milk as well as the water. Due to the short time of mammary gland secretion in sows (approx. 30 seconds), colostrum and milk were collected after a previous intramuscular injection of 3 ml of oxytocin. Pelleted dry feed mixture (Creep feed 3, De Heus®) was provided from the seventh day after the birth of the piglets. The sows in the maternity ward were fed three times per day with the standard feed mixture for this category of pigs (KPK Vital, De Heus®), while its quantity depended on the number of piglets in the litter.

Experimental design

The faecal pH was determined at the birth of the piglets (within 24 hours), and also on the 7th, 14th, 21st, and 28th day of their life. After collection, the samples were immediately examined in the laboratory. The experiment also included the analysis of the pH of the fed feed mixtures and water. The respective legislative rules concerning animal welfare were observed during manipulation with animals.

Diagnostic testing

Upon arrival at the laboratory, the samples of faeces were diluted 1 : 3 with distilled water, according to the procedure described by Hydock, Nissley and Staniar [8]. The samples were stored at room temperature (20–23 °C) and stirred for one minute before measuring the pH. The measurements were performed using a calibrated Greisinger G 1500-GE pH meter (Greisinger®, Germany). The device was calibrated twice during the experiment and cleaned with a plastic brush and distilled water after each measurement. The measuring range of the instrument is from 0.00 to 14.00 pH, with an accuracy of ± 0.01 pH.

Statistical processing of results

The statistical processing of the results was performed by assessment of means (x) and standard deviations (SD). The significance (P) of differences in the means of corresponding variables were evaluated by One-way analysis of variance and by Tukey's Multiple Comparison Test. We used GraphPad Prism 9 for the statistical processing.

RESULTS

The pH value of piglet faeces showed an upward trend over a period of four weeks (Figure 1). We found the lowest values in the period up to 24 hours after birth. On the contrary, the highest values in the last week of the experiment (Table 1). During the entire experiment, the average pH ranged from 6.38 to 7.72. The lowest recorded value was 5.72, the highest 8.96. Tukey's multiple comparison test showed significant differences between the pH of new-born piglet faeces and samples taken in the following weeks of the experiment ($P < 0.05$; $P < 0.01$; $P < 0.001$).

Analysis of colostrum pH within 24 hours after farrowing the sows showed values close to 6.09, in the following weeks of lactation we recorded increased milk pH values. The highest pH values of milk were recorded in the 3rd week of the experiment (7.66 ± 0.02, Table 2.).

In the analyses of feed mixtures and water, the lowest values were recorded in the pelleted feed mixture for suckling piglets (Table 3).

DISCUSSION

Faeces are solid or semi-solid remains of food that has not been digested in the small intestine and has been broken down by bacteria in the large intestine. They are the

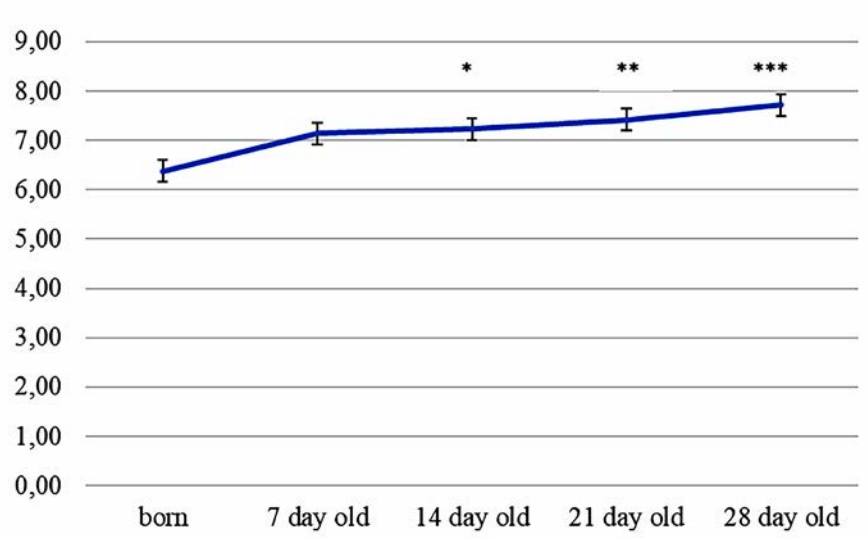


Fig. 1. Average pH of piglets' faeces

Table 1. pH values of piglet faeces (x ± SD)

	Born	7 days old	14 days old	21 days old	28 days old
Piglets/sow P15	5.72	7.04	7.10	7.55	7.60
Piglets/sow P16	6.22	7.08	7.16	8.02	8.96
Piglets/sow P17	6.29	7.55	7.23	7.53	7.91
Piglets/sow P18	7.01	7.32	7.15	8.03	7.76
Piglets/sow P19	6.79	6.89	6.98	6.73	7.42
Piglets/sow P20	5.99	6.97	7.30	7.60	7.21
Piglets/sow P09	6.65	7.16	7.70	6.47	7.20
x ± SD	**6.38 ± 0.46**	**7.14 ± 0.23***	**7.23 ± 0.23***	**7.42 ± 0.60****	**7.72 ± 0.61*****

Statistical significance: * – P < 0.05; ** – P < 0.01; *** – P < 0.001

Table 2. pH of colostrum (lactated within 24 hours) and milk of sows (x ± SD)

	Within 24 hours	7 days	14 days	21 days	28 days
Milk	6.09 ± 0.12	6.98 ± 0.04	7.08 ± 0.01	7.66 ± 0.02	7.01 ± 0.03

Table 3. pH of water and feed mixtures (x ± SD)

Feed	Water	Mixture for piglets	Mixture for sows
pH	7.19 ± 0.01	4.92 ± 0.18	6.07 ± 0.05

end products of the activity of the digestive tract, when intestinal fluid thickens due to water absorption [6, 22]. Daily production in healthy piglets is very low, only a few grams, which makes it difficult to obtain a sufficient amount of faeces samples and subsequent analysis. The small size of the anus and rectal ampoule also makes the collection difficult. For these reasons, in our experiment, we took fresh samples of faeces only during the spontaneous defecation of piglets.

Faeces examination can provide important information about diseases that affect the gastrointestinal system. Stool can be examined: macroscopically, microscopically, chemically, immunologically, and microbiologically [9]. Piglet diarrhoea is one of the most common pig diseases, leading to heavy mortality and thereby causing economic loss [25].

Assessment of diarrheal pH can be an initial step in clinical examination. Although researchers are not completely united on the best method of measuring pH, faecal pH is a suitable representation of what is happening in the gastrointestinal system. Accuracy depends on the number sampled because variation within a population of scouring pigs can be expected. Sufficient stool to determine pH can usually be obtained by gently squeezing the abdomen of diarrheic piglets. Stools of piglets with colibacillosis are rich in bicarbonate and tend to be alkaline, i.e. pH 8 or greater. Malabsorptive diarrhoeas due to atrophic enteritis commonly are pH 7 or less. Variations within groups of pigs are expected, and mixed infections are common [3].

Faecal pH values depends on the diet. Suckling piglets receive colostrum only within 24 hours after birth [18], and then the basis of their nutrition is milk. Milk secretion can be divided into two parts, transient milk and mature milk depending on composition in each period. The transitional milk is a secretion from 34 hours after birth to the 4th day of lactation, characterized by a high concentration of fat [19]. Mature milk is released from the following days of lactation until weaning, with the milk composition being relatively stable [15, 16]. The penetration of serum from blood vessels into the glandular follicles of active mammary glands has a fundamental effect on the pH of milk [5].

The pH of sow colostrum is more acidic than that of mature milk. Kent et al. [10] reported that the pH of colostrum immediately before and after parturition was 5.7, rising to 6.0 at day 1, and reaching 6.9 by day 9, consistent with other reports [5]. In our experiments, we found the lowest pH within 24 hours after the birth of piglets (pH of colostrum 6.09 ± 0.12), on the contrary, we found the highest pH of milk 21 days after the birth of suckling piglets (7.66 ± 0.02). One must not forget about the potential intake of water (if there is enough breast milk, the intake is limited) and the intake of piglets' feed mixture – pre-starter. In our experiments, this mixture was provided from the 7th day of life, but the actual intake did not start until a few days later, depending on the milk yield of the sows. The pH of feed depends on the feedstuffs used. The pH of our feed mixture was around 4.9. The suckling piglet has been use to a low stomach pH during lactation because lactic acid bacteria from the sow milk convert lactose to lactic acid [11]. Lactic acid helps to lower the pH of the sucklings' stomachs. In addition, acid production in the gastrointestinal tract has been shown to modify the composition of the gut microflora by lowering gut pH, thereby reducing the growth and proliferation of some gut pathogens [7].

CONCLUSIONS

Our experiment allowed us to come to the conclusion that in healthy suckling piglets, the lowest pH of faeces is during colostrum intake with a gradual increase in the values measured on the 7th, 14th, 21st and 28th days of the piglets' life. Measuring the pH of faeces can be a suitable examination in the evaluation of the health status of the digestive tract of piglets.

ACKNOWLEDGEMENTS

This study is the result of implementation of the project: "Open scientific community for modern interdisciplinary research in medicine (OPENMED)", ITMS2014+: 313011V455, supported by the Operational Programme Integrated Infrastructure, funded by the ERDF.

REFERENCES

1. **Baumhak, M. J., Michima, L. E. S., Andrioli, B. M., Brandi, R. A., Weigel, R. A., Belli, M. N. C. B., Siqueira, R. F., 2021:** Buffering capacity and faecal pH in healthy horses submitted to experimental enteral nutrition. *Semin. Cienc. Agrar.*, 42, 6, 3793–3802. DOI: 10.5433/1679-0359.2021v42n6Supl2p3793.
2. **Berg, M., Hoskin, S. O., Rogers, Ch. W., Grinberg, A., 2013:** Faecal pH and microbial populations in thoroughbred horses during transition from pasture to concentrate feeding. *J. Equine Vet.*, 33, 4, 215–222. DOI: 10.1016/j.jevs.2012.06.004.
3. **Bergeland, M. E., Henry, S. C., 1982:** Infectious diarrhoeas

of young pigs. *Vet. Clin. North Am. Large Anim. Pract.*, 4, 2, 389–399. DOI: 10.1016/s0196-9846(17)30113-1.

4. **Chiang, C. C., Croom, J., Chuang, S. T., Chiou, P. W. S., Yu, B., 2008:** Development of a dynamic system simulating pig gastric digestion. *Asian-Australas. J. Anim. Sci.*, 21, 10, 1522–1528. DOI: 10.5713/ajas.2008.70640.
5. **Coffey, M. T., Seerley, R. W., Mabry, J. W., 1982:** The effect of source of supplemental dietary energy on sows' milk yield, milk composition and litter performance. *J. Anim. Sci.*, 55, 1388–1394.
6. **Diem, K., Lentner, C., 1970:** Faeces. In *Scientific Tables*, 7th edn., Basle, Switzerland, CIBA-GEIGY Ltd., 657–660.
7. **Fukuda, S., Toh, H., Hase, K., Oshima, K., Nakanishi, Y., Yoshimura, K., et al., 2011:** Bifidobacteria can protect from enteropathogenic infection through production of acetate. *Nature*, 469, 543–547.
8. **Hydock, K. L., Nissley, S. G., Staniar, W. B., 2014:** A standard protocol for faecal pH measurement in the horse. *Prof. Anim. Sci.*, 30, 6, 643–648. DOI: 10.15232/pas. 2014-01346.
9. **Kasırga, E., 2019:** The importance of stool tests in diagnosis and follow-up of gastrointestinal disorders in children. *Turk. Pediatri. Ars.*, 25, 54, 3, 141–148. DOI: 10.14744/TurkPedia triArs.2018.00483.
10. **Kent, J. C., Arthur, P. G., Hartmann, P. E., 1998:** Citrate, calcium, phosphate and magnesium in sows' milk at initiation of lactation. *J. Dairy Res.*, 65, 55–68.
11. **Kim, Y. Y., Kil, D. Y., Oh, H. K., Han, I. K., 2005:** Acidifier as an alternative material to antibiotics in animal feed. *Asian Australas. J. Anim. Sci.*, 18, 1048–1060.
12. **Maes, D., Chantziaras, I., Vallaey, E., Demeyere, K., Meyer, E., Janssens, G. P. J., 2021:** Faecal pH throughout the reproductive cycle of sows in commercial pig herds. *J. Anim. Physiol. Anim. Nutr.* (Berl.), 105, 4, 687–692. DOI: 10.1111/ jpn.13370.
13. **McCormack, U., Curião, T., Wilkinson, T., Metzler-Zebeli, B., Reyer, H., Ryan, T., Lawlor, P., 2018:** Faecal microbiota transplantation in gestating sows and neonatal offspring alters lifetime intestinal microbiota and growth in offspring. *mSystems*, 3, 3, e00134-17. DOI: 10.1128/mSystems. 00134-17.
14. **Niederwerder, M., Jaing, C., Thissen, J., Cino-Ozuna, A., McLoughlin, K., Rowland, R., 2016:** Microbiome associations in pigs with the best and worst clinical outcomes following co-infection with porcine reproductive and respiratory syndrome virus (PRRSV) and porcine circovirus type 2 (PCV2). *Vet. Microbiol.*, 188, 1–11. DOI: 10.1016/j.vetmic. 2016.03.008.
15. **Nuntapaitoon, M., Juthamanee, P., Theil, P. K., Tummaruk, P., 2020:** Impact of sow parity on yield and composition of colostrum and milk in Danish Landrace × Yorkshire crossbred sows. *Prev. Vet. Med.*, 181, 105085.
16. **Nuntapaitoon, M., 2022:** Colostrum and milk in sow. In *Milk Protein – New Research Approaches*. IntechOpen. DOI: 10. 5772/intechopen.102890.
17. **Osuka, A., Shimizu, K., Ogura, H., Tasaki, O., Hamasaki, T., Asahara, T., et al., 2012:** Prognostic impact of faecal pH in critically ill patients. *Crit. Care*, 10, 16, 4, R119, DOI: 10. 1186/cc11413.
18. **Quesnel, H., Farmer, C., Devillers, N., 2012:** Colostrum intake: Influence on piglet performance and factors of variation. *Livest. Sci.*, 46, 105–114.
19. **Quesnel, H., Farmer, C., Theil, P. K., 2015:** Colostrum and milk production. In *The Gestating and Lactating Sow*. Wageningen Academic Publishers, The Netherland, 173–192.
20. **Sciascia, Q. L., Daş G., Metges, C. C., 2016:** Review. The pig as a model for humans: Effects of nutritional factors on intestinal function and health, *J. Anim. Sci.*, 94, Suppl. 3, 441–452, DOI: 10.2527/jas.2015-9788
21. **Snoeck, V., Cox, E., Verdonck, F., Joensuu, J. J., Goddeeris, B. M., 2004:** Influence of porcine intestinal pH and gastric digestion on antigenicity of F4 fimbriae for oral immunisation. *Vet. Microbiol.*, 14, 98, 1, 45–53. DOI: 10.1016/j.vet mic.2003.10.020.
22. **Tortora, G. J., Anagnostakos, N. P., 1987:** *Principles of Anatomy and Physiology*, 5th edn., Harper and Row Publishers., New York, 624 pp.
23. **Wen, X., Wang, L., Zheng, C., Yang, X., Ma, X., Wu, Y., Jiang, Z., 2018:** Faecal scores and microbial metabolites in weaned piglets fed different protein sources and levels. *Anim. Nutr.*, 4, 31–36. DOI: 10.1016/j.aninu.2017.10.006
24. **Whitehouse, C., Pagan, J. D., Coleman, R. J., 2013:** Responses in faecal pH from low to high starch intakes in healthy horses. *J. Equine Vet. Sci.*, 33, 5, 358–359.
25. **Yue, S., Li, Z., Hu, F., et al., 2020:** Curing piglets from diarrhoea and preparation of a healthy microbiome with *Bacillus* treatment for industrial animal breeding. *Sci. Rep.*, 10, 19476. DOI: /10.1038/s41598-020-75207-1.

Received August 12, 2022
Accepted September 19, 2022