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Changes in the pH of colostrum and milk during the lactation of sows

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Abstract: *The aim of this work was to analyse the dynamics of changes in the pH of colostrum and milk during the lactation of sows. Eight clinically healthy sows (Duroc x Pietrain breed) farrowed at the Pig Clinic of the University of Veterinary Medicine and Pharmacy in Košice were included in the experimental monitoring. The first collection of colostrum was carried out within the first 24 hours after farrowing the sows. Additional milk samples were taken at the same intervals on the 7th, 14th, 21st and finally on the 28th day after delivery. The acidity of the analysed samples changed dynamically during the 28 days of the experiment. The lowest pH was recorded in the colostrum of sows, where the average value was 6.06. The average value of milk pH was 6.86 on the 7th day, 7.03 on the 14th day, 7.14 on the 21st day and 6.98 on the 28th day. Statistical comparison of colostrum with other milk samples revealed significant differences ($p<0.001$).*

Keywords: *colostrum, milk, pH, sows*

I. INTRODUCTION

Lactation is an essential part of reproduction in mammals, and each animal species has evolved unique lactation strategies that optimize the growth and development of their young [1]. A long-term analysis of sows' milk proves that milk is the most important food component for piglets, which affects their rearing, thereby significantly influencing reproductive parameters [2, 3, 4].The yield of sow milk is affected by genetics, nutrition, lactation stage, milking frequency, sow body weight, metabolic state, litter size, environmental temperature, quantity and development of milk parenchyma [5, 6].Optimum acidity values of sow's milk are essential for the absorption of nutrients and the support of the overall health and vitality of the piglets.

The aim of this experimental work was to analyse the dynamics of changes in the pH of colostrum and milk during the lactation of sows.

II. Materials and Methods

Animals and conditions in farrowing house

Eight sows that gave birth at the Pig Clinic of the University of Veterinary Medicine and Pharmacy in Košice were included in the experiment. The sows were in good nutritional condition, without clinical signs of disease and without observable pathological changes on the mammary glands or elsewhere on the body. They were placed in farrowing boxes with a free housing type, in sufficiently large pens with a concrete floor and a rubber mat. The pens were divided into two separate parts for the sow and litter. The sows were fed dry complete feed mixture OŠ – 09, which is intended for the given group of sows with unlimited access to water. The piglets were fed naturally, by sucking breast milk from the mother. From the 7th day of age, they received granulated feed pre-starter (De Heus®). Milk samples were collected directly in the pens.

Milk collection

About an hour before milking, it was necessary to separate the piglets from the sow. Two anterior pairs of mammary glands were cleaned and degreased with alcohol. Subsequently, 30 I.U. of oxytocin (Biovet®) applied intramuscularly to the sow's neck muscle. After 5 minutes from the application, feed was given to calm the animal. Samples were taken in the standing position of the sow. The first sampling was done the first 24 hours after the farrowing of the sow, by which we obtained colostrum; the other samplings were performed on the seventh, fourteenth, twenty-first and finally the twenty-eighth day after birth. These collections were made at the same time in the morning. The samples were examined immediately after collection.

Measuring the pH of milk using a pH meter

Calibration of the pH meter is required before collection to ensure accurate measurements in the samples. This procedure was performed regularly before each measurement of the collected samples. First, the pH meter electrodes were cleaned with distilled water, then pH 4 and pH 7 calibration solutions were prepared. The pH meter electrodes immersed in the pH 7 calibration solution were left there for a while. Subsequently, the calibration of the pH meter was started. Finally, the accuracy of the pH meter was checked on standard solutions of pH 4. The milk was mixed before analysis to ensure a homogeneous sample. The pH meter was inserted into the middle part of the container in which the milk was collected so that the electrodes did not touch the sides and were freely in the milk. After a short time and stabilization of the values on the display, the pH values were read. The measurement process was repeated twice to increase the accuracy of the measurement.

Statistical processing of results

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 processes.

III. Results

The acidity of the analysed samples changed dynamically over the course of 28 days (see graph and table), on the seventh day it changed by 13% of its value, which represents approximately 0.80 pH. On the fourteenth day, it reached an alkaline pH, on the 28th day, at the end of lactation, it again fell below pH 7. On average, the pH in colostrum in sows reached a value of 6.06, on the 7th day 6.86, on the 14th day 7.03, on the 21st day 7.14 and on the 28th day 6.98. Statistical analysis and comparison of colostrum with other milk samples revealed significant differences ($p<0.001$). The most acidic milk pH was recorded in the colostrum of sow 5 with a value of 5.70 (see table). Conversely, the most alkaline pH was recorded for sow 1 on day 21 with a value of 7.67, which is a 34% difference between the highest and lowest pH. According to these results, we could conclude that the pH of milk tends to rise after farrowing.

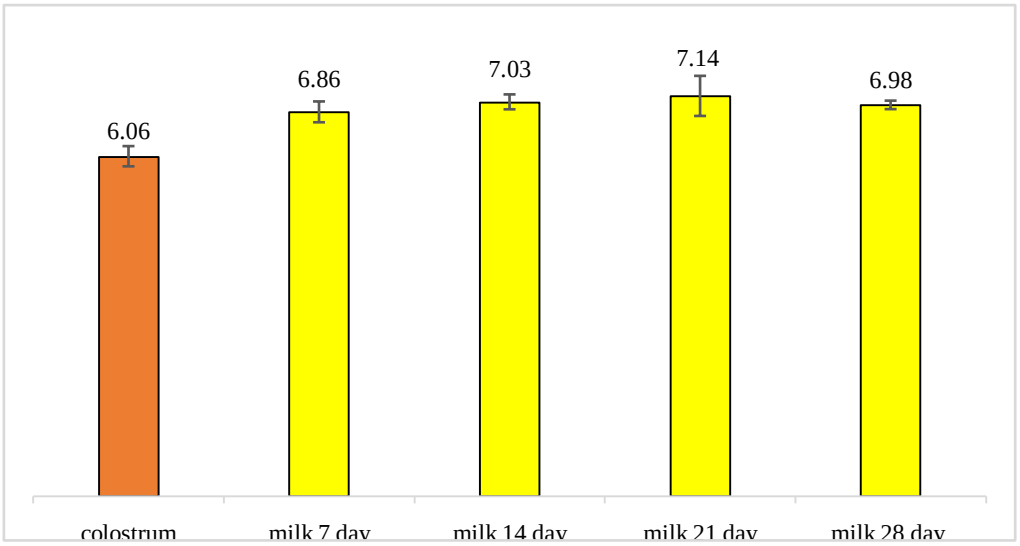

Figure 1. Average pH value of colostrum and milk

Table 1. Individual pH values of colostrum and milk

	Colostrum	Milk 7th day	Milk 14th day	Milk 21st day	Milk 28th day
Sow 1	6.20	7.01	7.07	7.67	7.02
Sow 2	6.18	6.95	7.09	7.64	7.04
Sow 3	6.13	6.60	6.85	6.71	6.88
Sow 4	5.91	6.90	6.96	6.98	7.04
Sow 5	5.70	6.67	7.20	7.01	7.05
Sow 6	6.04	7.08	7.16	7.10	6.91
Sow 7	6.25	6.98	7.09	7.23	7.02
Sow 8	6.09	6.65	6.85	6.78	6.88
x	**$6.06^{a,b,c,d}$±0.18**	**6.86^{a}±0.19**	**7.03^{b}±0.13**	**7.14^{c}±0.36**	**6.98^{d}±0.08**

Legend: ^{a,b,c,d}Different letters in a row at statistical significance p <0.001

IV. Discussion

Sows usually have about seven functional pairs of mammary glands in the thoracic (2), abdominal (4) and inguinal (1) regions [7]. The choice of thoracic mammary glands for our experiment was deliberate, because they produce the largest volume of colostrum and milk. However, before the collection, it was necessary to administer oxytocin intramuscularly to the sows. Since it was necessary to separate the litter from the mother, because piglet saliva changes the pH of colostrum and milk. Moreover, there are no cisterns in sow mammary glands.

Suckling piglets receive colostrum only within 24 hours after birth [8], 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 [9]. Mature milk is released from the following days of lactation

until weaning, with the milk composition being relatively stable [10, 11]. The penetration of serum from blood vessels into the glandular follicles of active mammary glands has a fundamental effect on the pH of milk [12]. The pH of sow colostrum is more acidic than that of mature milk. Kent et al. [13] 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 [12]. In our experiments, we found the lowest pH within 24 hours after the birth of piglets (pH of colostrum 6.06 ± 0.18), on the contrary, we found the highest pH of milk 21 days after the birth of suckling piglets (7.14 ± 0.36).Rekiel [14] in her analyses reported acidity of less than 7.0, indicating good health condition of sows and their mammary glands.

Several factors can affect the acidity of a sow's milk. The composition of the feed plays an important role here. Its nutritional content, especially carbohydrates, plays a key role in determining the acidity of milk. Another important factor is the health and welfare of the sow, which affects the quality and composition of the milk. Diseases and stress can fundamentally change the acidity of milk, so it is important to maintain optimal health conditions. The environment in which the sow is housed can affect her stress level and, consequently, the composition of the milk. Maintaining comfortable and stress-free conditions is key to supporting optimal milk production. A sow's genetic predisposition can contribute to variations in milk composition, including acidity. The selection of animals can also affect the level of acidity of the sow's milk. Farm management such as feeding regime, lactation frequency and overall herd management can also affect the acidity of a sow's milk. Consistent and well-designed management practices contribute to stable milk quality. In addition, seasonal changes and environmental conditions can affect the availability and quality of feed for sows and thus the acidity of the milk. Adequate nutrition, especially during periods of environmental stress, is key to maintaining milk quality. Bacterial contamination of milk can lead to fermentation processes and thus to a change in the acidity of the sow's milk. [5, 6, 15, 16, 17].

V. Conclusion

Sow milk acidity plays a key role in influencing the growth and health of piglets during the lactation period. Understanding the dynamic changes in sow milk acidity over time is essential for optimizing pig nutrition and ensuring their overall health.

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