

THE FUNCTIONAL STATE OF THE STOMACH IN CALVES IN THE FIRST MONTH OF POSTNATAL LIFE

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Introduction

It is known that in the first month of postnatal life in calves the adaptation of the digestive organs from a periodical consumption of liquid feed to permanent forage microbial digestion starts (Zabielski, 1999; Zachwieja, 2002; Constable, 2003; Sauter, 2003). However, the data on the fact how the rumen of calves is adapting to start a microbial digestion of feed in the first month of the postnatal ontogenesis, how the pH of the rumen and abomasum changes during this period of development in association with the animal nutrition, what is the acid secretion intensity of the abomasum before and after feeding, and which part of the regulating mechanism of the acid secretion of the stomach – neural or humoral – prevails in calves in this period of development. That is why the aim of this work was to investigate the functional changes of the rumen and abomasum at the same time in calves in the first month of life – during the period of colostrum and whole milk feeding, and at the beginning of forage feeding.

Tasks of work

Investigate the pH –dynamics in the rumen and abomasum in the calf in the first day of postnatal life before and after feeding.

Investigate the pH changes in the rumen and abomasum at the same time in calves during the period of colostrum and whole milk feeding as well as starting a period of feeding forage.

Investigate the effect of neural and humoral regulating mechanisms on the HCl secretion in the abomasum in calves during the first month of their life.

Material and methods

Sixteen animals were used in the experiment. Chronic fistulae were operated in the rumen in five calves immediately after birth; in three calves fistulae were operated in the rumen when they reached four days of age, but in eight calves at the age of 1 – 2 weeks fistulae were operated in the rumen and abomasum at the same time. Totally, 84 functional examinations of the abomasum and rumen were carried out.

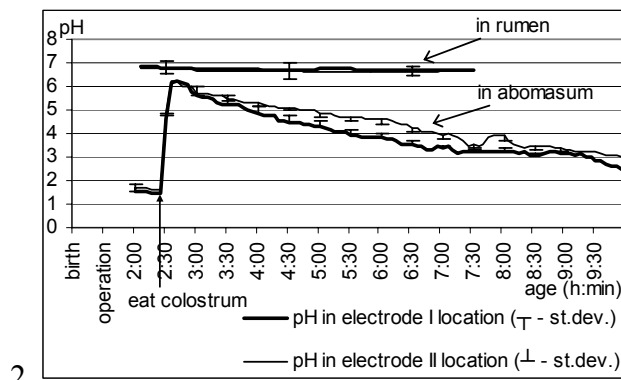
In the first day of postnatal life a continuous (8 hours) potentiometrical intra-abomasal pH measurements were carried out through the abomasal fistulae before and 7.5 hours after feeding one liter of colostrum. Starting from two days of age, the continuous potentiometrical intra-abomasal pH measurements were carried out in calves through the fistula four hours before and four hours after feeding.

During the first four days of postnatal life potentiometrical intraruminal pH measurements were carried out in calves 15 minutes before feeding, one, three and four hours after feeding of colostrum through a pH probe inserted *per os*. Starting from five days of age, the functional examination of the rumen in calves was carried out through the fistula four hours before and four hours after feeding.

The neural and humoral effect on the HCl secretion regulating mechanism of the abomasum was investigated in six 1 – 4 weeks old calves with operated in chronic fistulae. As a block of the neural effect of the hydrochloric acid secretion, 0.06 mg/kg atropine sulphate was administered intravenously, but as a block of the humoral effect of the hydrochloric acid secretion, 0.16 mg/kg cimetidine was injected intravenously (Plumb, 1995). In total, 96 physiological examinations were carried out in this experiment. A two-electrode pH probe was used for probing (1 calomel and 2 antimony electrodes).

Results and discussion

The pH-dynamics of the rumen and abomasum *in vivo* in newborn calves two to ten hours after birth and two to six days old ones are represented in Figures 1 and



2.

Fig. 1. pH dynamics in the rumen and abomasum of newborn calves in relation to feeding.

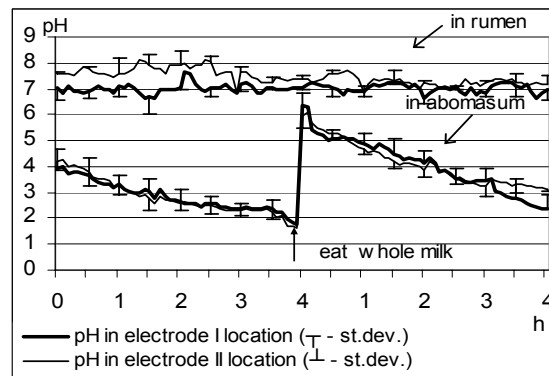


Fig. 2. pH dynamics in the rumen and abomasum of 2–6 days old calves in relation to feeding

The present investigations have shown that a calf is born with a marked acid intraabomasal reaction. Two hours after birth pH was 1.6 ± 0.21 ($P = 95\%$) before feeding.

After feeding one liter of colostrum, the acid level in the abomasum decreased to pH 6.2 – 6.5 (Fig. 1). The intraabomasal pH-dynamics in a newborn calf in the first day of its life indicates that HCl activity of the abomasum is sufficiently high, that allows to reach again a comparatively high level of acid concentration after seven hours of feeding colostrum. Some authors are of the opinion that there is no HCl secretion in the abomasum of a calf during the first two days of its life (Moran, 2002). Nevertheless, we cannot agree to that because our experimental results do not prove that. We share the opinion that the HCl secretion level in the abomasum of a calf immediately after birth is not an obstacle for the most important components of colostrum to transfer into the circulatory system unchanged (Longenbach, 1998; Zabielski, 1999).

As regards the pH-dynamics in the rumen in a newborn calf in the first day of its life, it was almost not changing and remained at the same level of 6.6 – 7.0, while in calves at the age of two to six days the intraruminal pH was already slightly different on various levels of the rumen four hours before the animal feeding (Fig. 1 and 2). In the ventral part of the rumen pH was on average within the range of 7.45 – 8.15, but at the same time in the dorsal part of it pH was 6.6 – 7.65. The intraruminal reaction has a tendency to equalize and become stable slightly alkaline within the range of pH 7.0 – 7.2 (Fig. 2).

Two hours before the feeding of calves pH ranged from 2.0 to 3.0 in the abomasum, but 10 – 15 minutes just before their feeding pH reached even 1.4 – 1.7. Such a rapid increase of the acid concentration in the abomasum before eating shows evidence that the conditioned response to the eating time appears in the calf already with the second day of its life. Therefore, it would be preferable to feed calves strictly at one and the same time, starting from the second day of their postnatal life.

The results of this experiment suggest that the intraabomasal pH 3.0 levels in two to six days old calves was reached already in 3.5 hours after feeding (Fig. 2). Restoration of the acid level in the abomasum in calves indicates the stomach emptying process (Heinrich, 1998; Longenbach, 1998).

When analyzing the functional status of the stomach in one to three days old calves, it turned out that the rumen reaction is more even both before and after feeding (Fig. 3) in comparison with that of the rumen pH-dynamics in two to six days old animals. According to the obtained data, the average rumen pH level in calves of this period of age was 7.0 ± 0.56 . This meets the

requirements of the optimum rumen setting for the aminolytic processes of microorganisms (Martinez, 1999).

The intraabomasal pH-dynamics in one to three weeks old calves generally do not differ from that in the animals of colostrum period (Fig. 3.). It should be stressed that in animals at this age the intraabomasal acid level increased one hour earlier than in two to six days old calves.

The stomach pH-dynamics in four weeks old calves before and after feeding with whole milk will be considered further (Fig. 4).

It was observed that in four weeks old calves about two hours before feeding regular moments of increased alkaline intraruminal setting appeared, when pH increased on average from 6.97 to 7.73. At those moments the ruminated portions of feed, mixed with saliva, were swallowed. In the rumen they caused the pH ranging waves of alkaline level which were registered.

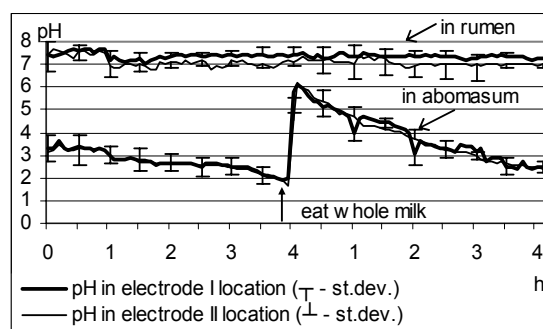


Fig. 3. pH dynamics in the rumen and abomasum of 1-3 weeks old calves in relation to feeding

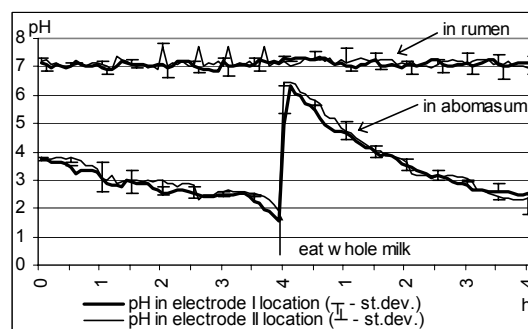


Fig. 4. pH dynamics in the rumen and abomasum of 4 weeks old calves in relation to feeding

As regards the effect of neural and humoral mechanisms on the hydrochloric acid secretion in the abomasum in calves, it was stated that both atropine sulphate and cimetidine caused a blocking effect of the HCl secretion in 7 – 31 days old animals (Tab.1).

Table 1

pH changes, caused by atropine sulphate and cimetidine, in the abomasum of 7-31 days old calves

Age (days)	pH-probe I or II electrode	pH 30 min before the experiment		pH 30 min after atropine sulphate. injection		Changes (pH units)	pH 30 min after cimetidine injection		Changes (pH units)
		n	mean±st.dev.	n	mean±st.dev.		n	mean±st.dev.	
7-13	I	12	2.93±0.38	6	3.10±0.43	0.17	6	4.16±0.61	1.23**
	II	12	3.06±0.47	6	3.37±0.35	0.31**	6	4.18±0.57	1.12**
14-20	I	12	3.31±0.53	6	3.72±0.51	0.41**	6	4.95±1.23	1.64**
	II	12	3.36±0.55	6	3.80±0.52	0.43**	6	5.18±1.13	1.82**
21-27	I	12	3.63±0.52	6	3.70±0.07	0.07	6	5.81±0.75	2.18**
	II	12	3.24±0.51	6	3.47±0.57	0.22*	6	5.65±0.71	2.41**
28-31	I	12	3.35±0.54	6	3.93±0.30	0.58**	6	5.14±0.94	1.79**
	II	12	3.07±0.36	6	4.25±0.40	1.18**	6	4.58±1.10	1.51**

* – difference is significant with probability P=95%;
** – difference is significant with probability P=99%.

As the atropine sulphate injections caused a considerably less increase of pH level, compared to the effect caused by cimetidine, a conclusion can be drawn that the secretory effect of *n. vagus* in the regulating mechanism of HCl secretion in the abomasum in calves at this age is weaker than that of the histamine effect. Especially expressed it was in 21 – 27 days old animals.

It should be pointed out that starting to eat forage and concentrated mixed feed, the role of the prestomach in the process of feed digestion increases. Moreover, histamines, present in the feedstuffs, begin to flow into the abomasum without interruption thus changing the regulating effect of neural and humoral mechanism on the HCl secretion in the abomasum.

Conclusion

The calf is born with a pronounced acid intraabomasal reaction (pH 1.6 ± 0.21). After the first feeding pH in the abomasum increases rapidly, but after seven hours the acid concentration again reaches a sufficiently high level (2.83 ± 0.05).

A newborn calf in the first day of its life has a low acid reaction of rumen setting (pH 6.73 ± 0.12), but in the animals in the colostrum and whole milk period, especially when they start consuming forage, the intraruminal setting has a tendency generally to become more alkaline. Starting from the second day of postnatal life, 10 – 15 minutes before the usual feeding the acid concentration in the abomasum increases rapidly (even up to pH 1.4–1.7 level) that shows evidence of appearance of the conditioned response to the feeding time.

After feeding 2 – 2.5 liters of milk in two to six days old calves the intragastric acid level in the abomasum repairs on an average already in 3.0-3.5 hours, but in calves at the age of four weeks – in 2.5 – 3.0 hours.

In the regulating mechanism of abomasum HCl secretion in the calf in the first month of postnatal life, both neural and humoral effect is important, however, the prevailing role has the humoral effect, especially in animals ages 21 – 27 days.

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