

## THE EFFICACY OF FEED ON THE INTRA-RUMINAL AND INTRA-ABOMASAL PH DYNAMICS IN GOATS

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**Abstract.** The effect of feed on the intra-ruminal and intra-abomasal pH dynamics in goats was investigated. Chronic fistulas were operated in the rumen and abomasum. The pH dynamics in adult animals was estimated in each part of the stomach separately after feeding the concentrated mixed feed, fodder beet and hay, or after feeding the concentrated mixed feed and hay simultaneously. The intra-ruminal and intra-abomasal pH dynamics in three-month-old kids was estimated after feeding them the concentrated mixed feed, hay and mother's milk. All the experimental animals were kept under similar circumstances and fed with equally balanced feed. Physiological investigations were started at 0600, prior to animal feeding and continued from 04 00 to 07 00 hours after feeding. Multielectrode pH probes, Oakton glass electrodes and pH meter were used. Comparing three months old kids intragastral pH in abomasum (in the morning before feeding) the adult animal intra-abomasal pH we concluded, that reaction of intraabomasal medium environment on an empty stomach is less acid. It oscillates from 3.9 pH to 5.5 pH for kids; for adult animals from 4.4 to 4.5. In the meantime, intra-ruminal pH for young animals in the morning before feeding was 7.5 to 7.7, but for adult goats - 7.9 to 8.3.

**Keywords:** goat, rumen, abomasum, pH dynamics

## PAŠARO ĮTAKA PH DINAMIKAI OŽKŲ PRIESKRANDYJE IR TINKLAINĖJE

**Santrauka.** Buvo tiriama pašaro įtaka pH dinamikai ožkų prieskrandyje ir tinklainėje. Šiuose organuose buvo padarytos fistulos. pH dinamika buvo matuojama suaugusių gyvūnų organizme, kiekvienoje skrandžio dalyje, pašėrus koncentruotais pašarais, pašariniais runkeliais ar šieniu, arba tuo pat metu pašėrus koncentruotais pašarais ir šieniu. Buvo matuojama pH dinamika trijų mėnesių amžiaus ožkų prieskrandyje ir tinklainėje, pašėrus jas koncentruotais pašarais, šieniu ir motinos pienu. Visi eksperimentiniai gyvuliai buvo laikomi tomis pačiomis sąlygomis ir šeriami vienodai subalansuotais pašarais. Fiziologiniai tyrimai buvo atliekami 6 val. prieš rytinį šėrimą ir tęsiami 4-7 valandas po šėrimo. Tyrimams buvo naudojami daugiaelektrodingi pH zondai, oktaniniai stikliniai elektrodai ir pH-metras. Lyginant trijų mėnesių amžiaus veršelių skrandžio pH ir tinklainės pH prieš rytinį šėrimą su suaugusio gyvulio pH tinklainėje, mes darome išvadą, kad tinklainės terpės rūgštingumas, esant tuščiam skrandžiui, yra mažesnis. Jis kinta nuo 3.9 iki 5.5 jauniklių organizme ir nuo 4.4 iki 4.5 suaugusių ožkų organizme. Tuo tarpu, prieskrandžių pH jauniklių organizme prieš rytinį šėrimą kito nuo 7.5 iki 7.7, o suaugusių ožkų organizme – nuo 7.9 iki 8.3.

**Raktažodžiai:** ožka, prieskrandis, tinklainė, pH dinamika

**Introduction.** Physiological investigations on goats have been carried out in Latvia. Such kind of studies were necessary to estimate the functional condition of the stomach in animals of different age in association with the feed in order to estimate the initial health condition of the experimental animals for further experiments when goats will be infected with certain species of nematodes of digestive organs most often found in Latvia.

The functional condition of the stomach in ruminants of different age has been found to be different. During the first days of life, the digestive processes in ruminants are similar to those of animals with one-chamber stomach because the forestomach is not completely developed. Its development is gradual alongside with the transfer from milk to the feed of plant origin. For example, a typical way of digestion and metabolism of adult cows start to develop at the age of 2-4 months (Birģele et al., 1999, 2000). In adult goats, 58% of the feed dry matter, including 93% fiber, 80% of soluble carbohydrates and 11% of protein are digested in the forestomach (Ridges, Singleton, 1962). In goats, about 56.8g of fatty acids are formed of 100g digestible matter in the rumen, 19% in the omasum and abomasum, but 5% enter the intestines

(Weston, Hogan, 1968). The volatile fatty acids, as it is known, are the main source of energy.

In goats, similar to other ruminants, nutrients and bacterial proteins, synthesized in the rumen, are further digested by the enzymes and hydrochloric acid, which are secreted by the mucosa glands in the abomasum. It should be pointed out that a certain acidity of the medium, i.e., pH, is needed for the normal functional process in the forestomach and abomasum. It has been estimated that the optimal pH for the proteinase and peptidase, produced by bacteria in the rumen, is 5.5 to 7.0, for the cellulase –7.0, for the desaminase –6.5 to 7.0, but for the decarboxilase –3.0 to 5.0. To provide a normal synthesis of the volatile acids in the rumen, the pH of its contents must be 6 to 8. If the pH is lower than 5.8, the amount of the butyric acid and ketone bodies is increased (Курилов, Кроткова, 1971, Алиев, 1997). According to M. Smith's and D. Sherman's (1994) data, the average pH is  $7.35 \pm 0.3$  in the rumen of goats. The pH of the ruminal and abomasal content depends on the amount and content of the feed, substances produced while it is digested, the intensity of the salivation and other factors which are of great importance for proper animal feeding, for protection of their health and raising their productivity.

The optimal pH in the abomasum in ruminants is a rather disputable issue, as different authors have quite different data. Obviously, it is due to the fact that pH has been measured mainly *in vitro*. In addition, as mentioned above, the animal age, feed and many other factors affecting these indices should be taken into consideration.

**The aim** of the work was to investigate the intraruminal and intra-abomasal pH dynamics in goats in association with the feed.

**Material and methods.** Investigations were carried out January through April, 2002 in the Preclinical Institute of the Faculty of Veterinary Medicine (FVM) LUA. For the experiment 3-mo-old kids and goats at 10-14 mo of age were used. Permanent, the so called chronic fistulas, were operated in the rumen and abomasum of animals. All the animals were provided with similar feeding and handling circumstances in the clinic of the FVM. All the animals were clinically healthy.

The intraruminal and intra-abomasal pH in adult goats was measured:

1. prior to morning feeding,
2. after feeding 0.4kg of the concentrated mixed feed and 0.4kg of hay simultaneously,
3. after feeding 0.4kg of the concentrated mixed feed,
4. after feeding 1.0kg of fodder beet,
5. after feeding 4.0kg of meadow hay.

The intra-abomasal pH dynamics in 3-mo-old kids was measured in the morning prior to feeding and after feeding 0.2kg of the concentrated mixed feed, mother's milk and 2.0kg of hay. It should be stressed that animals were fed in such a way at least for two months.

Investigations were carried out applying the intragastric potentiometric method with multielectrode pH probes (with two antimone electrodes 12cm from each other and one calomel electrode at the end of the probe). The validity of the pH measurements were checked by Oakton (Singapore) glass electrode measurements. The intragastric pH probes were inserted into the rumen and abomasum. The probe is close to the ventral wall of the rumen, but the other one –12cm higher. In the abomasum the probe was inserted towards the pyloric gland area; so the upper end electrode was located close to the pyloric sphincter. In that way the upper and electrode had to fixed (record) the possible flux of the duodenum content into the abomasum (during the duodenogastric reflux) (Birģele, 1997). The stomach functional investigations were started at 0600 prior to animal feeding and were still continued from 4 to 7 hours after feeding. Thus, the continuous intra-ruminal and intra-abomasal pH metry in goats lasted at least for 6 to 7 hours. Analogous investigations were carried out five times in each animal. The total amount of examined animals was six. The obtained data were processed statistically (Arhipova et al., 1998).

**Results and discussion.** The results are showed in figures 1 to 10. In all the 10 to 14 months old goats, the pH in the rumen was rather alkaline 8.0 to 8.5. After feeding the concentrated mixed feed and hay at the same time, the content of the rumen became more acid (Fig.1),

in the second and the third hour after feeding the pH was 7.3 to 7.5, but in the fourth and sixth hour after feeding the pH was already 7.0 to 7.3. As regards the changes of the pH level in the rumen in goats after feeding the concentrated mixed feed (Fig.2) or hay (Fig.3) or only fodder beet (Fig.4), the changes of the reaction of the ruminal content caused by the mentioned feedstuffs were slight, and it remained comparatively alkaline during the four hour period. In general, the lowest pH indices were recorded in the fourth hour after feeding hay, in the third hour-after feeding the concentrated mixed feed, in the second hour- after feeding fodder beet. In general, the pH of the ruminal content in these investigations was higher than after feeding the mixed feed. To some extent, that accounts for the small amount of the feed fed to goats. Obviously, the saliva neutralized the volatile acids, produced during the fermentation processes, which made the rumen content change towards the acid.

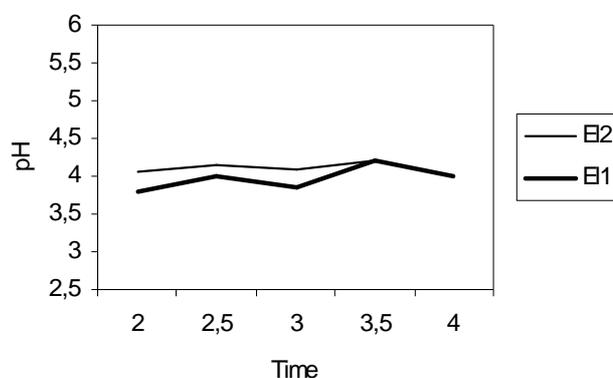


Fig. 1. pH level in the rumen after feeding the concentrated mixed feed and hay at the same time

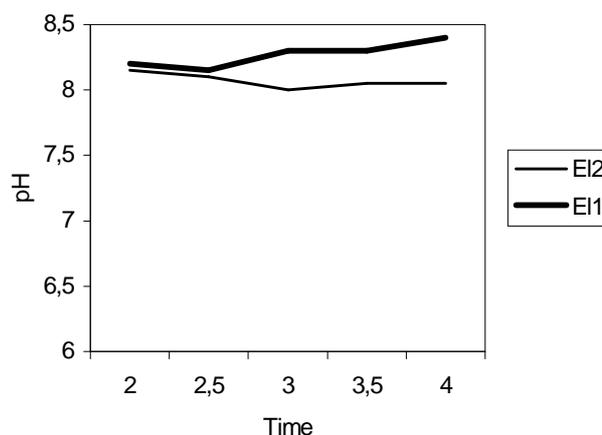


Fig. 2. pH level in the rumen after concentrate mixed feeding

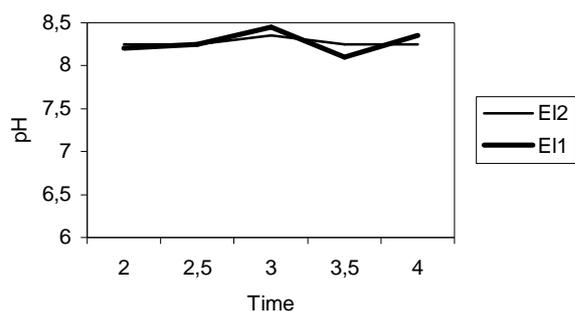


Fig. 3. pH level in the rumen after hay feeding

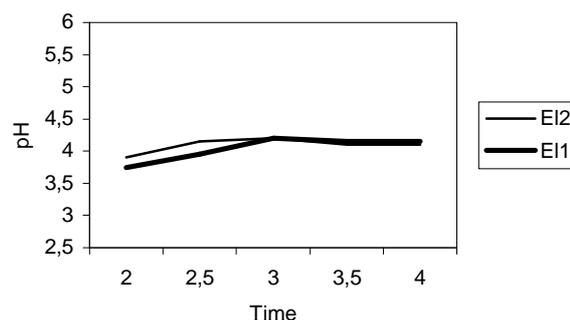


Fig. 5. pH level in the rumen of three old kids after concentrated mixed feed, hay and mother milk feeding

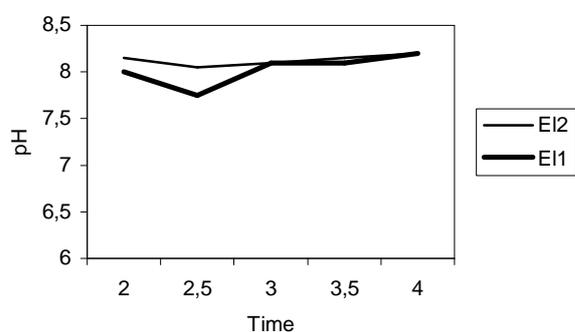


Fig. 4. pH level in the rumen after fodder beet feeding

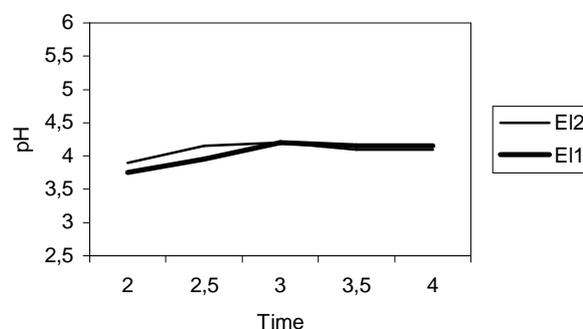


Fig. 6. pH level in the abomasum after feeding the concentrated mixed feed and hay at the same time

It is known that in sheep and goats 110 to 170g of hydrogen carbonates are secreted by the saliva per twenty-four hours, maintaining the saliva pH in the range of 8 to 10. Thus, the ruminal content, at least during the first four hours after feeding hay, the concentrated mixed feed or fodder beet separately, was more or less alkaline. As regards the intra-ruminal pH in 3-mo-old kids (Fig.5), it should be stressed that in young animals the ruminal content in the morning prior to feeding was more "acid" in comparison with that of the goats at the age of 10 to 14 months. In the morning prior to feeding the intraruminal pH was 7.2 on average. The pH increased just after feeding and reached even 7.7 to 7.9 levels, especially in the second hour after the feed intake. Probably, these indices could be affected by independent intake of mother's milk before sampling. The intra-abomasal medium reaction on an empty stomach in 10 to 14 months old goats was on average (pH 4.4-4.5), but after the feed intake the pH tended to decrease (Fig.6-9). After feeding the concentrated mixed feed and hay at the same time, the pH indices of the abomasum content decreased during the third and fourth hour (pH 4.2). Afterwards, in the fifth hour it increased a little until (pH 4.3-4.4), but in the sixth and the seventh hour the medium reaction of the abomasum again became more acid (pH 4.0-4.2).

These pH changes in the abomasum could be associated with an intensive use of the rough forage in the forestomach in goats. The content of the five stomach flows into the abomasum regularly, thus changing its pH.

Similar pH ranges in the abomasum were observed in the experiments on calves (E.Birgele et al., 1999). On feeding 0.4kg of the concentrated mixed feed (Fig.7) or 4.0kg of meadow hay (Fig.8), or 1.0kg of fodder beet (Fig.9) separately, the intra-abomasal pH dynamics was slightly different. The pH level decreased after animal feeding (the degree of acidity increased) more rapidly exactly the first two hours and reached pH 3.7 to 4.0. Further on (three or four hours after the feed intake), in the different areas of the abomasum the pH ranged from 3.9 to 4.2

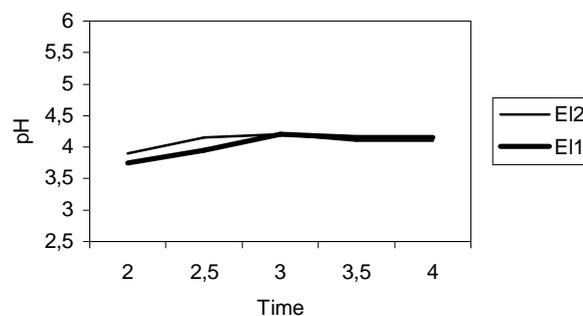


Fig. 7. pH level in the abomasum after concentrate mixed feeding

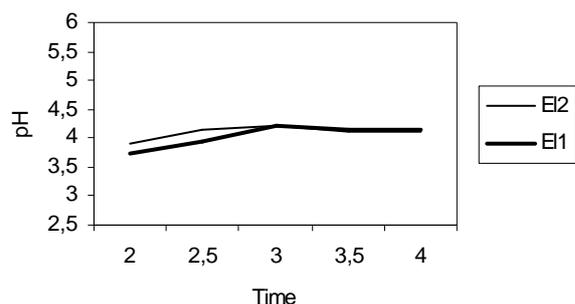


Fig. 8. pH level in the abomasum after hay feeding

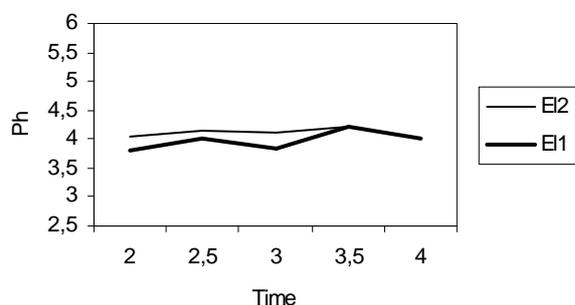


Fig. 9. pH level in the abomasum after fodder beet feeding

after feeding the concentrated mixed feed, while it was 4.1 to 4.5 and 3.8 to 4.2 after feeding hay and fodder beet, respectively. The results show that the most acid intra-abomasal medium reaction was after fodder beet feeding, but it was less acid after meadow hay feeding. As regards the intra-abomasal pH dynamics in kids at the age of 3 months (Fig.10), the medium reaction in the abomasum was comparatively less acid than that of the 10 to 14 month old goats.

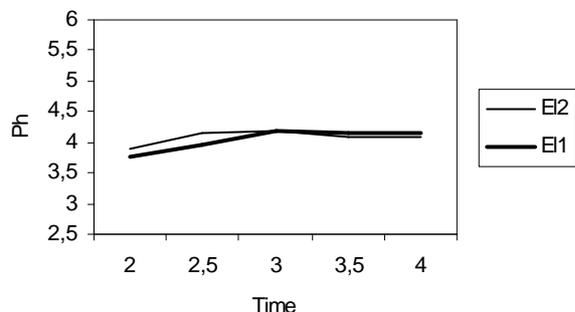


Fig. 10. pH level in the abomasum of three month old kids after concentrated mixed feed, hay and mother milk feeding

Prior to the morning feeding, the intra-abomasal pH was on average 4.6 to 5.4. After the feed intake the pH indices decreased and ranged from 3.9 to 5.2. The electrode that was located closer to the wall of the abomasum showed more acid reaction. The lowest pH indices (3.9 to 4.6) were in the second and the third hour after feeding, whereas later, in the fourth hour they increased again (pH 4.3 to 5.2.)

To conclude, the investigations on the simultaneous intraruminal and intra-abomasal pH dynamics in goats showed evidence of the differences in the changes of the medium reaction in the rumen and abomasum. They were dependent on both the feed and the age of animals.

#### Conclusions.

1. The intraruminal and intra-abomasal pH dynamics in goats depends on the content of feed, the time passed after the animal feeding and the age of animals.

2. The intraruminal and intra-abomasal pH is different in 3-month-old kids and in adult goats: in young animals, in the morning prior to feeding the pH of the content of the rumen is lower (the content is more acid) than that in the adult animals; at the same time the intra-abomasal medium is slightly less acid in comparison with that in the adult goats.

3. After eating, the medium reaction in the rumen and abomasum tends to become more acid. In adult goats (10 to 14 mo of age) the most acid intra-abomasal medium reaction was caused by feeding 1.0kg of fodder beet, (average pH 4.0).

4. The lowest intraruminal pH indices in goats were after feeding the concentrated mixed feed and hay at the same time; they ranged on average from pH 8.0 to 7.0 during the seven-hour period.

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