Continual monitoring of reticulorumenal pH of dairy cows during 45 days

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The aim of the study was to continuously monitor reticuloruminal pH in 7 dairy cows of Holstein breed during 45 days at University Experimental Farm in Oponice. The bolus pH and temperature values implemented via *esophagus* were measured every 15 minutes (96 data points per day) with accuracy ±0.1 pH. Data were downloaded and collected with HathorHBClient v. 1.8.1 and statistically evaluated with IBM SPSS v. 20.0 (One-way ANNOVA). Statistically significant differences between average values of pH from all dairy cows every hour (P <0.05) were found. Overall the average pH was 6.28±0.32. The lowest pH recorded was 5.30 and the highest 7.39. During 24 hours of day were dairy cows on average 6 hours and 51 minutes (28.6% of a day) between pH ranges 6.2–6.4. The second longest period of pH values were between 6.4–6.6 and took on average 6 hours and 8 minutes (25.6% of a day). The shortest part of a day was pH over 6.8. It was only 0.6% representing 8 minutes and 34 seconds.

Keywords: monitoring, reticuloruminal pH, dairy cows

1. Introduction

High-producing dairy cattle require large amounts of dietary energy to meet the demands of increased milk production. To accommodate this energy requirement, it has often been economical for producers to feed large amounts of cereal grains to provide energy to rumen microbes and their host. Cereal grains contain large quantities of highly fermentable carbohydrates that can result in a build-up of organic acids in the rumen and reduce rumen buffering (Kleen et al., 2003; Stone, 2004), causing a depression in rumen pH. Highly fermentable diets are rapidly converted to organic acids (i.e., short-chain fatty acids and lactic acid) within the rumen. The resulting release of protons can constitute a challenge to the ruminal ecosystem and animal health. Health disturbances, resulting from acidogenic diets, are classified as subacute and acute acidosis based on the degree of ruminal pH depression. Low rumen pH for prolonged periods each day can negatively affect feed intake, microbial metabolism, and nutrient degradation, and low ruminal pH is related to inflammation, laminitis, diarrhea and milk fat depression (Stone, 2004; Krause and Oetzel, 2006; Enemark, 2008). Gastiener et al. (2012) used for monitoring of reticuloruminal pH, an indwelling and wireless data transmitting system. The aim of the study was to continuously monitor reticuloruminal pH in 7 dairy cows during 45 days.

2. Material and methods

Measured data from 7 dairy cows of Holstein breed (average age 3.57) in cooperation with the University Experimental Farm in Oponice during 45 days were collected. Selected cows have average milk production 10 175 kg per lactation with 3.94% of fats, 3.10% of crude proteins and 4.7% of lactose. Animals were fed once with Total Mix Ratio (Table 1) *ad libitum* (between 4th and 5th hour) and milked 3 times per day (6:00 a.m., 12:00 a.m. and 6:00 p.m.). Every dairy cow has implemented farm bolus for continual data measuring which was implemented through *esophagus* orally with the use of special balling gun. The bolus pH and temperature values were measured every 15 minutes (96 data points per day) with accuracy ±0.1 for pH. Used boluses (eCow Devon, Ltd., Great Britain) are characteristic with its small

Table 1 Total mix ratio composition

	Dry matter in %	As feed in kg	Dry matter intake in kg
Maize silage	34.54	22.00	7.60
Haylage	32.20	18.00	5.80
Feed mixture	88.77	8.62	7.65
High moisture corn	67.93	5.40	3.67
Cottonseed	92.00	0.80	0.74

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dimensions (135 × 27 mm) and weight 207 g. Data were downloaded with the handset with antenna and dongle connected with USB dongle connector with the radio frequency 434 MHz in the milking parlour. Collected data were summarized with HathorHBClient v. 1.8.1 and statistically evaluated with IBM SPSS v. 20.0 (One-way ANNOVA, Tukey Test).

3. Results and discussion

Daily average pH development of 7 dairy cows is shown in the Figure 1. These average values of pH are recalculated from 45 days and sorted from 0:00 a.m. to 11:00 p.m. Statistically significant differences between average values of pH from all dairy cows every hour (P <0.05) were found. Totally, the average pH was 6.28±0.32. The lowest pH recorded was 5.30 pH (Cow ID 1038) and the highest 7.39 (Cow ID 1023). As ruminal acid production from fermentation of carbohydrates highly varies from meal to meal, ruminants possess highly developed systems to maintain ruminal pH within a physiological range of about 5.5–7.0 (Krause and Oetzel, 2006). After comparison of daily pH development of observed animals we found the same tendency of curved lines. This finding points out to the same daily regime of animals. It can be stated that feeding was realized between 4:00 a.m. and 5:00 a.m. due to peak of average pH values of dairy cows at this time from 6.26 ±0.16 (Cow ID 1023) to 6.79 ±0.15 (Cow ID 1038). Keunen et al. (2002) found before first feeding pH ranges between 6.5–6.8. After feeding sudden decrease of pH values are caused by higher content of highly digestible starch in the daily diet. This drop of pH values continued to 3:00 p.m. when stabilization of pH development at the lowest level 5.93 ±0.25 (Cow ID 1038) and at the highest level 6.50 ±0.12 (Cow ID 1023) was found. Later slight recovery at 5:00 p.m. and 6:00 p.m. with maximal average pH 6.62 ±0.14 in dairy cow 1204 and minimal average pH 6.02 ±0.22 in cow 1038 were detected. After third milking at 18:00 every figure line of pH hit lower value. At the

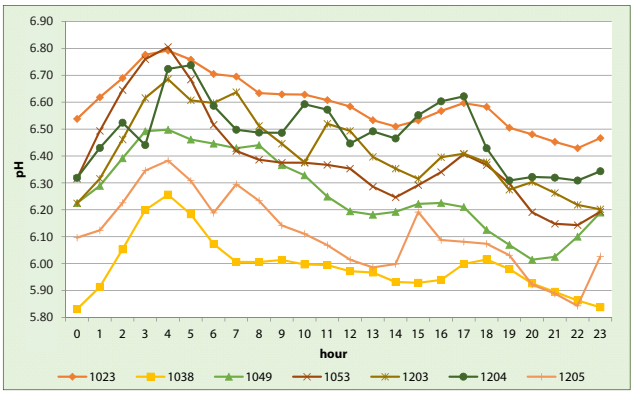

Figure 1 Daily average courses of reticuloruminal pH

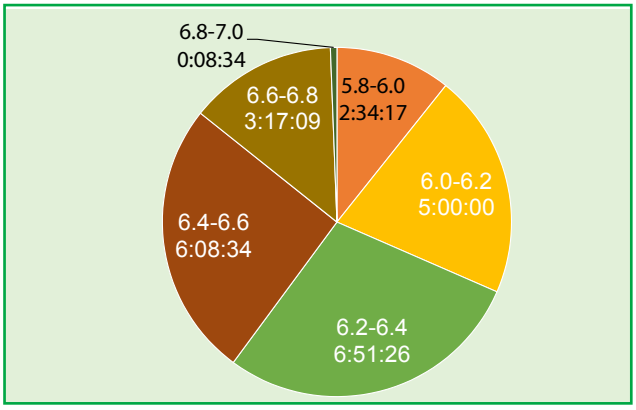

Figure 2 Average time in selected pH interval of monitored dairy cows during day for 45 days (hh:mm:ss)

end of the day pH values were from 5.84 ±0.24 (Cow ID 1038 at 11:00 p.m.) to 6.42 ±0.13 (Cow ID 1023 at 10:00 p.m.). After animal resting and ruminating the average reticuloruminal pH values reached fast their day peak before morning feeding. The same results found Keunen et al. (2002) when the rumen slowly returns to a normal rumen pH (6.3 – 6.8) overnight and is at its peak again the following morning. Maulfair et al. (2013) observed the lowest pH values from 5.28 to 5.59 and the highest

Table 2 Average pH values of dairy cows during observed period

Cow ID	Mean	Std. Deviation	Std. Error	Minimum	Maximum
1023	6.60[a]	0.18	0.00	6.18	7.39
1038	5.99[b]	0.26	0.00	5.30	6.77
1049	6.27[c]	0.24	0.00	5.47	7.05
1053	6.39[d]	0.26	0.00	5.43	7.09
1203	6.42[e]	0.22	0.01	5.97	6.94
1204	6.48[f]	0.22	0.01	5.48	6.94
1205	6.11[g]	0.21	0.01	5.59	6.67
Total	6.28	0.32	0.00	5.30	7.39

Different letters in the columns indicate significant differences. The mean difference is significant at the 0.05 level (Tukey Test)

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values of pH from 6.69 to 6.95. Another research recorded average pH values from 5.69 to 6.50 (Krause et al., 2009) and from 5.90 to 6.60 (Křížová et al., 2011).

During 24 hours of a day were dairy cows on average 6 hours and 51 minutes (28.6% of a day) between pH intervals 6.2–6.4. The second longest period of pH values were between 6.4–6.6 and took on average 6 hours and 8 minutes (25.6% of a day). Average period between pH 6.0–6.2 was 5 hours of a day representing 20.8% part of a day. It can be stated that 75% of day time ruminal pH was between 6.0 and 6.6. The pH values between 6.6 and 6.8 lasted 3 hours and 17 minutes, between 5.8–6.0 reach 2 hours and 34 minutes (together it was 24.4% of a day). The shortest part of a day was pH over 6.8. It was only 0.6% representing 8 minutes and 34 seconds. AlZahal et al. (2007) monitored ruminal pH below 5.6 for 5 hours daily and during another experiment found AlZahal et al. (2008) pH values in the rumen under 5.6 for 1 hour daily. Average daily pH values under 6.0 took 4 hours and 33 minutes of a day (Keunen et al., 2002).

4. Conclusions

After comparison of daily pH development of observed animals we found the same tendency of curved lines. Daily courses of pH values are influenced by individuality, order of lactation and health condition. The average pH in 7 dairy cows for 45 day was 6.28 ±0.32 and range of the interval was from 5.30 to 7.39. The most of the day time were average pH in zone 6.2–6.4 (6 hours and 51 minutes – 28.6% of a day). 75% of a day time ruminal pH was in the interval 6.0–6.0. Only 8 minutes and 34 seconds (0.6% of a day) was pH over 6.8 and 2 hours and 4minutes between 5.8 and 6.0 (10.7% of a day).

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