http://www
November 2016
Volume 4 Issue 10
NDS Dynamics

NDS Rumen pH sub-model – Part II

By Ermanno Melli, RUM&N Staff
with Dave Weber, DVM; NDS-NA and Buzz Burhans, PhD; Dairy-Tech Group & NDS-NA

Subacute ruminal acidosis

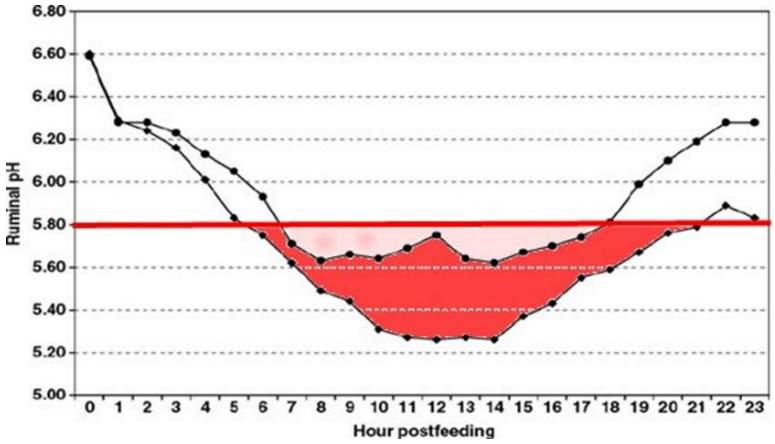
Subacute ruminal acidosis is defined as periods of moderately depressed ruminal pH (Beauchemin et al., 2003). It leads to a drop in acetate-to-propionate ratio, fiber digestibility, milk fat content, and DMI (Plaizier et al., 2008).
Maintenance of optimal rumen pH critically affects several important outcomes affected by ration formulation: optimal fiber digestion and thus feed efficiency, avoidance of butterfat depression, and avoiding pathological consequences of subclinical acidosis (SARA). These outcomes are all multifactorial, and not determined by rumen pH alone, but rumen pH is certainly a key and critical factor.
Rumen pH that defines SARA is not consistently defined and different pH threshold values are used. However, pH depressions below 5.6 to 5.8 are generally accepted as threshold values. The length of time per day when ruminal pH is under "suboptimal" levels seems a better determinant of depressed fiber degradation and presence of SARA than daily mean ruminal pH, or the lowest ruminal pH value.
Even though the time duration for which the ruminal pH must remain below this threshold value has not been precisely defined, ruminal pH of 5.8 is considered detrimental for rumen function, below which fiber digestion by the rumen microorganisms is suboptimal, and as a threshold for the development of SARA in dairy cows. However, it is assumed that the effects of ruminal pH on rumen function or SARA development depends on the duration of time in which pH remains below 5.8.
In order to minimize the risks of SARA, daily mean ruminal pH lower than 6.05 - 6.10 and a time length in which daily ruminal pH is below pH 5.8 longer than 5 hours or in which it is below pH 5.6 longer than 3 hours should be avoided.

In order to provide these assessments, the NDS Ruminal pH sub-model provides an estimate of the time below pH 5.6 and below pH 5.8.

Time below pH 5.6, h/day	1,42
Time below pH 5.8, h/day	3,86

Extent and severity of rumen acidosis

Rumen pH 5.8 was used as the threshold of acidosis. However, the duration of rumen pH below 5.8 reflects how long of the occurrence of rumen acidosis, but it does not reflect the extent and severity of rumen acidosis. With a view to better assess the acidosis status, the extent and severity of rumen acidosis should also be considered. Different extent of rumen pH depression can cause different responses, such as decreased fiber digestion (below 5.8), inflammation (below 5.6) and increased lactic acid production (below 5.2). Therefore, the effect of rumen pH depression to 5.7 for 3h may be different from rumen pH depression to 5.2 for 3h, for example.
For this purpose the assessment of the area of rumen pH below 5.8 (AUC, pH x min/day) as an indicator of the extent and severity of acidosis has been recently proposed (Penner et al., 2007 - Penner et al., 2009 – Gao et al., 2014).

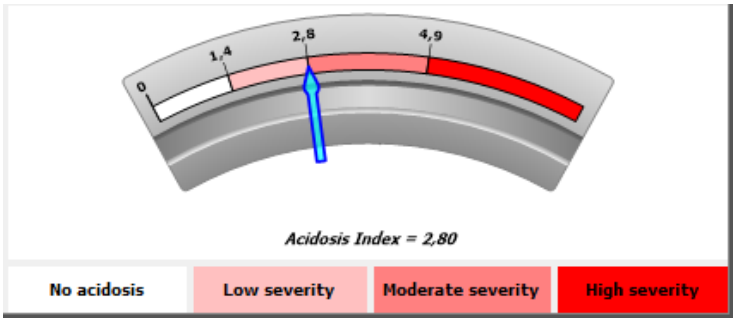


Area of pH below 5.8 was calculated by extent of rumen pH depression below 5.8 (5.8 – estimated minimum rumen pH value) * duration of pH measurement interval (h/day). For example, if the minimum rumen pH was estimated at 5.6, then area below pH 5.8 would be (5.8 – 5.6) * duration = 0.2 * time below pH 5.8. Area is used to reflect the extent and severity of rumen acidosis.

Area pH <5.8, pH x min/day	58,5

However, differences in feed intake may have different effects on rumen pH for animals, so that it seems sensible to normalize the parameter based on the DMI, in order to define a homogeneous Acidosis Index. Therefore, Acidosis index was calculated by dividing the area of rumen pH below 5.8 by DMI to evaluate the severity of rumen acidosis normalized for DMI. In the field, the occurrence, duration and severity of acidosis may be enough to evaluate the condition of rumen acidosis. Nevertheless, variation in individual animal effects and responses to rumen acidosis are found in practice (tolerant animals), and it is useful to account for factors causing this variation among animals. Using the acidosis index proposed, could remove the confounding effects of DMI on rumen pH, which helps to evaluate and target whether the severity of rumen acidosis is related to differences in other factors, such as VFA absorption and neutralization in the rumen.

Acidosis Index, pH <5.8 pH x min/day	2,80

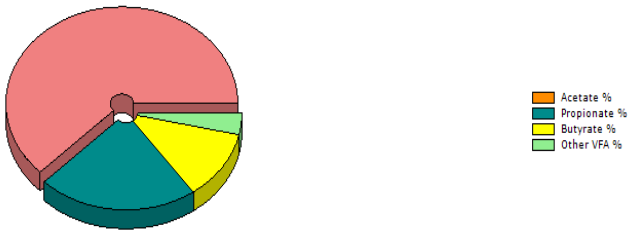


Volatile fatty acids in the rumen

The volatile fatty acids (VFA) produced by microbial fermentation in the rumen are the main source of energy absorbed by the digestive tract of ruminants. The amount and profile of VFA formed in the rumen has consequences for the efficiency of energy utilization, production of methane, risks of ruminal acidosis and composition of animal products.

Using an empirical approach, the NDS Ruminal pH sub-model provides a quantitative review on VFA yield in the rumen, based on several dietary parameters (Nozière et al., 2011).

	g/day	Moles/day	% Molar
Total VFA		92,9	100,0
Acetate	3.490	58,1	62,5
Propionate	1.536	20,7	22,3
Butyrate	946	10,7	11,6
Other VFA		3,3	3,6
Acetate:Propionate ratio	2,80		
Nonglucogenic:Glucogenic VFA	3,44		



In addition, Acetate to Propionate ratio (AP) and Nonglucogenic to Glucogenic (NGR) ratio are reported.
The NGR ratio seems to be of significant interest because the VFA profile, particularly the nonglucogenic (Acetate, Ac; Butyrate, Bu) to glucogenic (Propionate, Pr) VFA ratio (NGR), is associated with effects on methane production, milk composition, and energy balance.
To integrate the four individual VFA into one characteristic, the nonglucogenic to glucogenic VFA ratio (NGR) was calculated as [Ac + 2 x Bu + Branched chain VFA] / [Pr + Branched chain VFA].
According to the definition of this ratio, observed NGR is positively correlated with Acetate and Butyrate and negatively with Propionate. The NGR is related to the efficiency with which VFA are used for productive purposes, as it provides an indication of the partitioning of energy between milk and body mass.

The NDS Ruminal pH Sub-Model developed by the NDS team as described above, is not a component of the underlying CNCPS model, and does not change the model outputs or results. It is solely an implementation and the responsibility of RUM&N Company.

Note that the features and utilities developed by the NDS team described above are not components of the underlying CNCPS model, and do not change the CNCPS outputs or results. *Questions about use of these features should be directed to the NDS support team, and not to the CNCPS group at Cornell.*

NDS PROFESSIONAL
NUTRIMIX PROFESSIONAL

NDS North America Group
E-mail: ndsrumen@gmail.com
rumendvm@gmail.com
Phone: (316) 841-3270

RU.M.&N. LIVESTOCK MANAGEMENT & NUTRITION
RUM&N Sas
Via Sant'Ambrogio, 4/A
42123 Reggio Emilia - ITALY
E-mail: info@rumen.it