

## INTRODUCTION

Liver abscesses has been shown to negatively affect cattle growth performance and profitability of beef cattle. Nagajara and Chengappa, (1998) describe the pathogenesis of bovine liver abscess as more prone of development when cattle are offered high-grain based diets. Thus, inducing ruminal disfunction (acidosis) which can compromise the integrity of the primary barrier in the digestive tract. For reasons not yet unveiled, beef-on-dairy crossbred cattle are facing a challenge with the prevalence of liver abscesses. The limited knowledge regarding specific nutritional requirements for such animals and the rumen epithelial development (Bittante et al. 2020) impose a barrier for mitigation strategies. Ruminal papillae morphometrics development for Angus cattle were describe by Lopez et al. (2024) and Camron et. al. (2023). Pederzoli et. al. (2018) and Novak et. al. (2019) studies such topic for Hostein cattle, while beef-on-dairy are assumed to be intermediary. Thus, characterizing ruminal papillae morphology and cell organization becomes crucial to investigate potential interactions within the presence of liver abscesses for the crossbreeds.

Figure 1. Representation of pathogenesis of liver abscesses in cattle offered high-grain diets. Adapted from: Nagajara and Chengappa (1998).



## OBJECTIVE

To evaluate ruminal papillae morphology, histology, and ruminal volatile fatty acid (VFA) profile of feedlot (beef-on-dairy) heifers with abscessed and non-abscessed livers.

## MATERIAL AND METHODS

- A randomized complete block (kill group) design was used to source heifers upon harvest,  $n = 94$  from animals with liver abscesses, and  $n = 110$  without liver abscesses.
- Individual fragments from the cranial sac (morphometric assessment) and ventral sac (histologic assessment) of the rumen were collected, while ruminal fluid was taken upon animal harvest and immediately frozen (dry ice).
- The GLIMMIX procedure of SAS with animal as the experimental unit, the fixed effect of liver abscess presence, size (small or large) intensity (local or diffuse), location (left, right, both), or diffusion (local or diffuse), while lot ( $n = 27$ ) within harvest-group ( $n = 6$ ) was used as random effect.

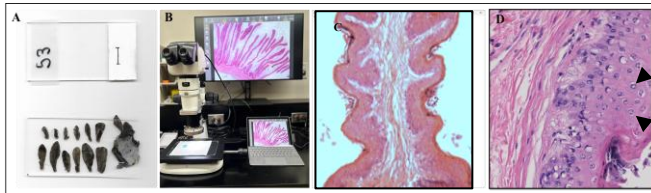


Figure 2. (A) Papillae count was performed by 3 trained individuals; 12 average-papillae fragment and fragment-base were scanned (ImageJ®); (B) Microscopic pictures for the histology assessment; (C) Representative section of bovine rumen papilla stained with Hematoxylin and Eosin (H&E); (D) 40X focus with arrows showing mitotic cells.

## RESULTS

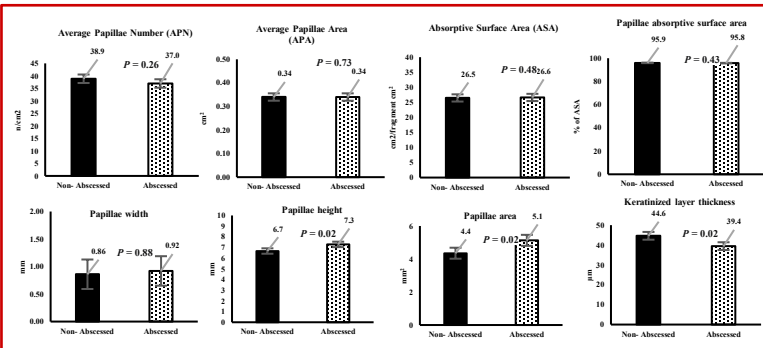


Figure 3. Morphometric characteristics of ruminal papillae tissue from animals with abscessed or non-abscessed livers.

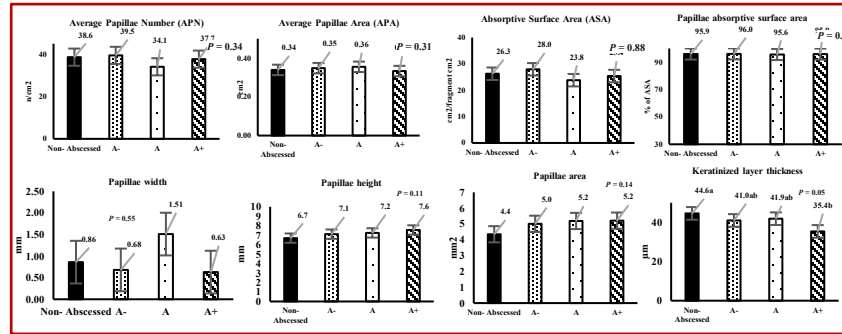


Figure 4. Morphometrics characteristics of ruminal tissue from animals with abscessed or non-abscessed livers, by abscess severity.

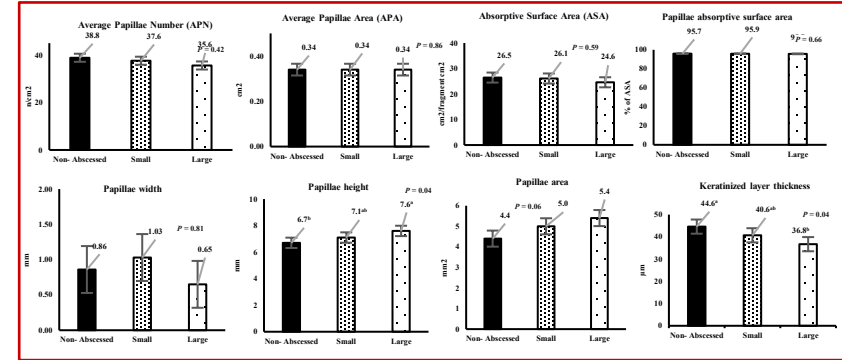


Figure 5. Morphometrics characteristics of ruminal tissue from animals with abscessed or non-abscessed livers, by abscess size.

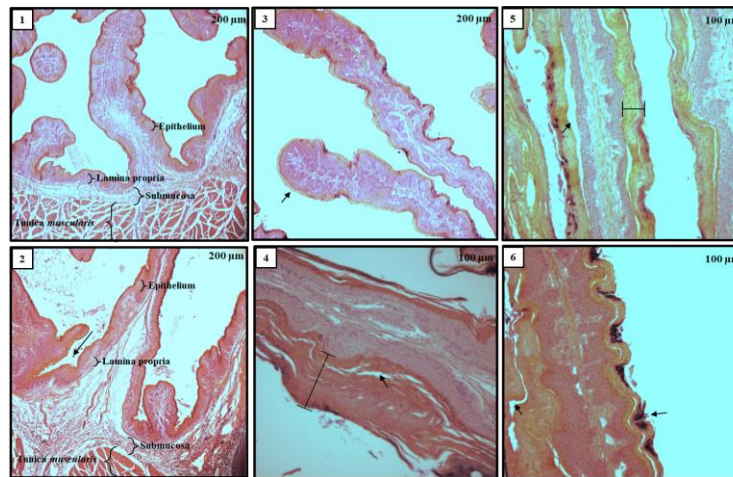


Figure 6. (1) Integrity of papillae shown in an animal with non-abscessed liver; (2) Papillae base with clefting scores with arrow pointing to extracellular spaces in an animal presenting a liver abscess A+; (3) Thinner keratinized papillae layer from an animal with liver abscess A+; (4, 5 and 6) high keratinized papillae layer with arrows showing sloughing scores from an animal with non-abscessed livers

Table 1. Ruminal VFA profile collected at harvesting time (Molar proportion)

Variables <sup>1</sup>	Non-Abscessed	Abscessed	P-value
Total (vFA)	100.2	95.79	0.44
Acetate	53.98	54.74	0.41
Propionate	27.95	27.14	0.31
Butyrate	10.13	10.27	0.72
Valerate	2.42	2.41	0.90
Isobutyrate	1.53	1.51	0.74
Isovalerate	3.74	3.68	0.78
Caproate	0.26	0.26	0.96
C2:C3	2.03	2.16	0.19
Branched	5.27	5.19	0.75

<sup>1</sup>mM/100 mM of vFA (mM).

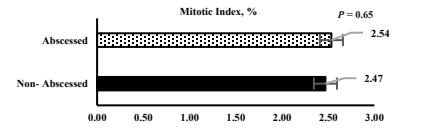


Figure 7. Mitotic Index, % (main effect of abscessed and non-abscessed livers)

Table 2. Morphometrics characterization of ruminal tissue from animals with abscess and non-abscessed liver, by abscess diffusion

Liver Abscess, by diffusion	None	Local	Diffuse	SEM <sup>*</sup>	P-value
<i>macroscopic variables</i>					
Number of papillae, n	39	37	37	2.8	0.53
Mean Papillae area, cm <sup>2</sup>	0.34	0.34	0.34	0.03	0.94
ASA <sup>**</sup> , cm <sup>2</sup> /cm <sup>2</sup> of rumen wall	24.3	25.4	25.7	1.99	0.77
Papillae area, % of ASA	96.0	95.7	95.9	0.33	0.65
<i>microscopic variables</i>					
Papillae width, mm	0.86	0.72	0.99	0.520	0.90
Papillae height, mm	6.69	7.56	7.20	0.415	0.06
Papillae area, mm <sup>2</sup>	4.35 <sup>b</sup>	5.61 <sup>a</sup>	4.96 <sup>ab</sup>	0.529	0.04
Papillae keratin, μm	44.6 <sup>a</sup>	43.7 <sup>ab</sup>	37.9 <sup>b</sup>	3.37	0.02
Mitotic index, %	2.47	2.50	2.55	0.213	0.87

<sup>\*</sup>Standard error of the mean.

<sup>\*\*</sup>Absorptive surface area.

Table 3. Morphometrics characterization of ruminal tissue from animals with abscess and non-abscessed liver, by abscess location

Liver Abscess, by lobe	None	Both	Left	Right	SEM	P-value
<i>Macroscopic variables</i>						
Number of papillae, n	39	36	44	37	4.1	0.24
Mean Papillae area, cm <sup>2</sup>	0.34	0.35	0.35	0.34	0.037	0.98
ASA <sup>**</sup> , cm <sup>2</sup> /cm <sup>2</sup> of rumen wall	26.3	24.8	30.5	25.7	2.87	0.25
Papillae area, % of ASA	95.9	95.7	96.7	95.8	0.17	0.17
<i>Microscopic variables</i>						
Papillae width, mm	0.86	1.20	0.69	0.64	0.789	0.79
Papillae height, mm	6.69	7.42	7.50	7.07	0.560	0.11
Papillae area, mm <sup>2</sup>	4.35	5.25	5.14	4.98	0.762	0.13
Papillae keratin, μm	44.6	40.2	37.6	39.1	4.99	0.14
Mitotic index, %	2.47	2.59	2.71	2.42	0.320	0.73

<sup>\*</sup>Standard error of the mean.

<sup>\*\*</sup>Absorptive surface area.

## CONCLUSION

Ruminal papillae quantitative and macroscopic assessment of morphology seemed not to be affected by the presence, severity, size or location of liver abscess, while histological microscopic measurements revealed that animals containing liver abscess (influenced by presence, size, and diffusion) had more pronounced and vulnerable ruminal papillae tissue.

## ACKNOWLEDGMENT

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