ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Lyon, France - August 28th / September 1st, 2023

Birth weight effect on performance and gut health status of weaned piglets

C. Negrini[1], F. Correa[1], D. Luise[1], S. Virdis[1], M. Mele[2], G. Conte[2], M. Mazzoni[3], P. Trevisi[1]

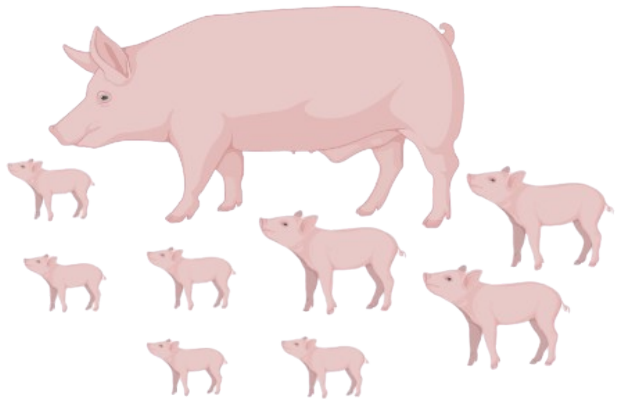
[1]University of Bologna, Department of Agro-Food Sciences and Technologies, Viale fanin 46, 40127, Italy,

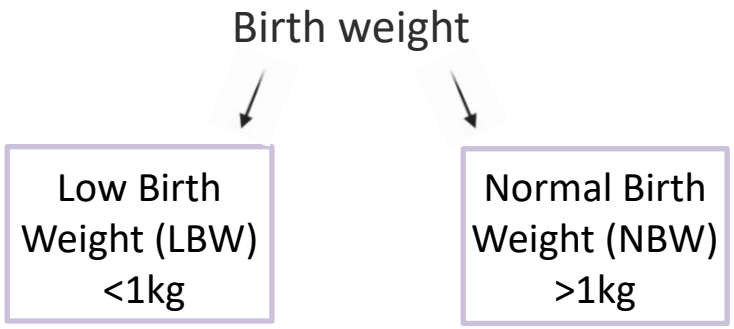
[2]University of Pisa, Department of Agriculture, Food and Environment, Via del Borghetto 80, 56124, Italy,

[3]University of Bologna, Department of Veterinary Medical Sciences, Viale fanin 46, 40127, Italy;

Background

- Over the last 20 years, the swine industry has focused on litter size as a key production indicator;
- By selecting for greater litter size, the drawback is that the number of piglets born with a Low Birth Weight increases;





- LBW ⋯⋯▸ Lowered nutrient absorption
  Impaired immune system
  (Lessars et al., 2018)
- BBW may have a long-term effect on the intestinal maturation of piglets

Lessard, M., Blais, M., Beaudoin, F., Deschene, K., Verso, L.L., Bissonnette, N., Lauzon, K., Guay, F. (2018). Piglet weight gain during the first two weeks of lactation influences the immune system development. Vet. Immunol. Immunopathol. 206, 25–34. https://doi.org/10.1016/j.vetimm.2018.11.005;

Background

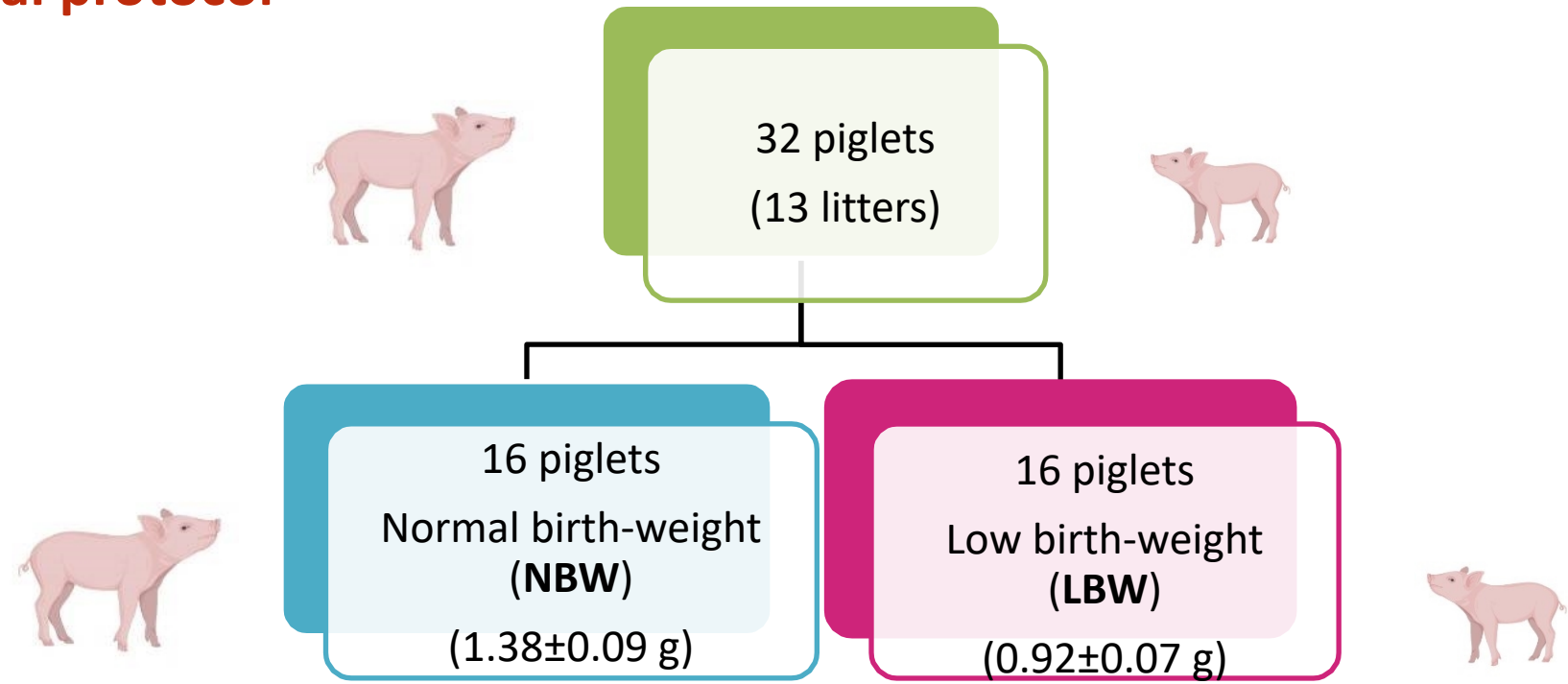
- Although in the literature there is a plethora of studies on LBW piglets, the majority are focused on the pre-weaning period.

- In fact, studies have mainly focused on LBW growth performances (Quiniou et al., 2002), entity of lesions and mortality (Van Tichelen et al., 2021), microbiota composition (Han et al., 2017), and digestive function (Michiels et al., 2013).

This study aims to assess the impact of birth body weight (BBW) on piglet performance, microbial profile, and gut status after weaning

Quiniou, N., Dagorn, J., Gaudré, D. (2002). Variation of piglets' birth weight and consequences on subsequent performance. Livest. Prod. Sci, Peri- and Post-Natal Mortality in the Pig 78, 63–70. https://doi.org/10.1016/S0301-6226(02)00181-1; Van Tichelen, K., Prims, S., Ayuso, M., Van Kerschaver, C., Vandaele, M., Degroote, J., Van Cruchten, S., Michiels, J., Van Ginneken, C. (2021). Handling Associated with Drenching Does Not Impact Survival and General Health of Low Birth Weight Piglets. Animals 11, 404. https://doi.org/10.3390/ani11020404;Han, G.G., Lee, J.-Y., Jin, G.-D., Park, J., Choi, Y.H., Chae, B.J., Kim, E.B., Choi, Y.-J. (2017). Evaluating the association between body weight and the intestinal microbiota of weaned piglets via 16S rRNA sequencing. Appl Microbiol Biotechnol 101, 5903–5911. https://doi.org/10.1007/s00253-017-8304-7

Experimental protocol



- Piglets were weaned at 25 days of age. No creep feed. Same post-weaning diet
- Divided into 8 pens per group (2 piglets/ pen) according to their class of BBW.
- Animals were weighted weakly until the end of the trial d21
- 8 piglets/ pen were scarified at **d9** (acute inflammatory phase) the other were scarified at **d21**

Experimental protocol

Samples collected from scarified pigs:

- **Blood samples:**

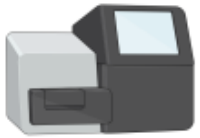
  - **ROMs** and **Haptoglobin** quantification

- **Jejunum Mucosa:**

  - **Gene expression***: NFKB2, IAP, CLAUD4*, *GPX-2*, *IL-8, MYD88*

  - **Jejunum Morphology and Immunohistochemistry** (Intraepithelial lymphocytes, number of IgA in lamina propria)

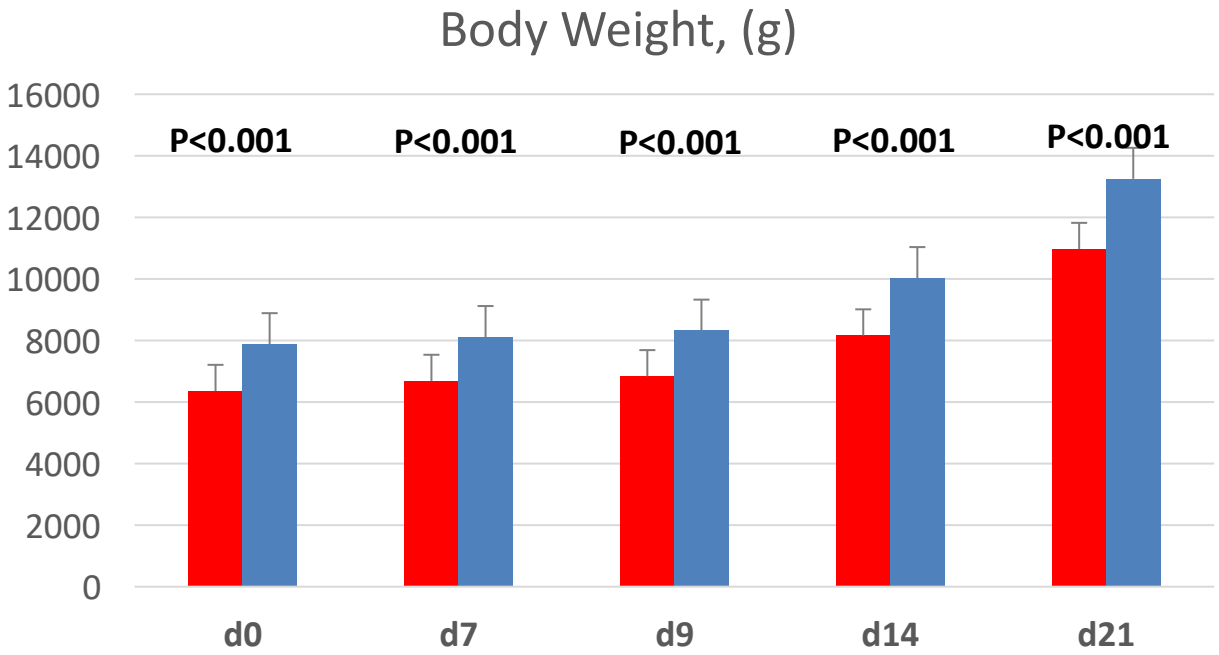
- **Colon Content:**



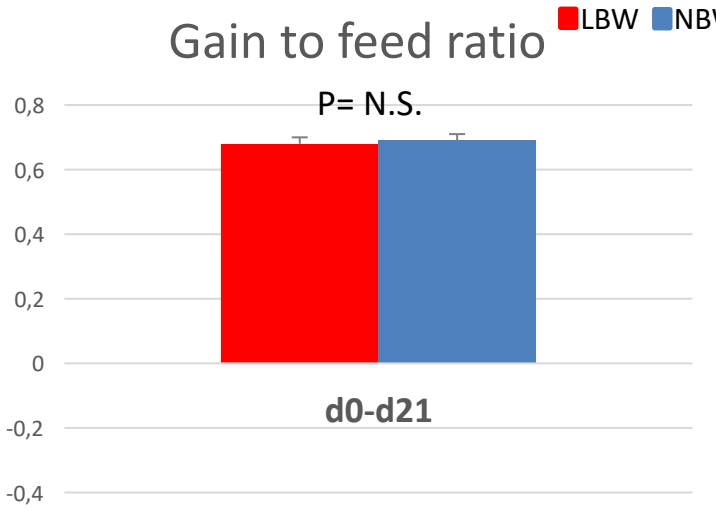
  - **16S microbiota** profiling

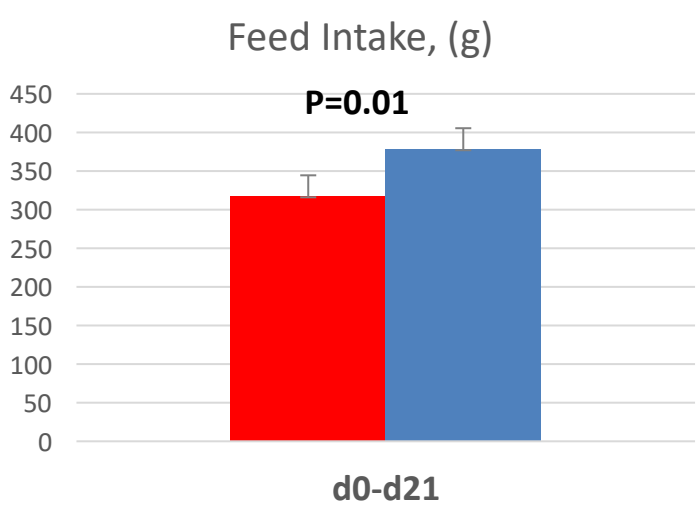
  - **Short chain fatty acids** production

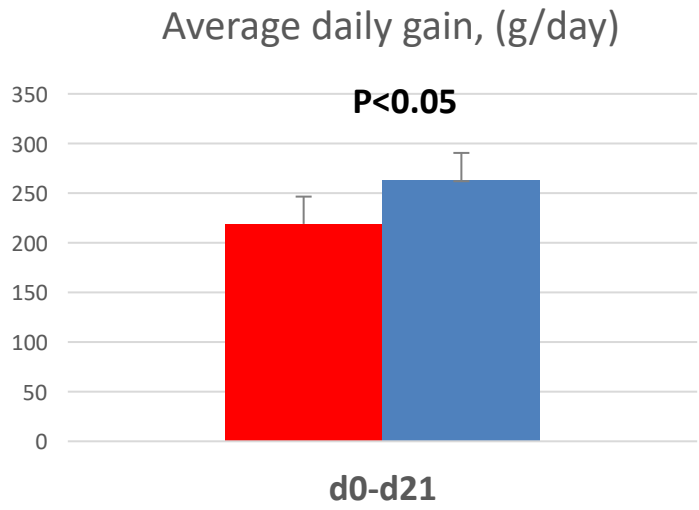
Results: Growth performance



The data showed that the BBW strongly impacted weight during the later life of the piglets as confirmed by previous studies on pigs (Fix et al., 2010)

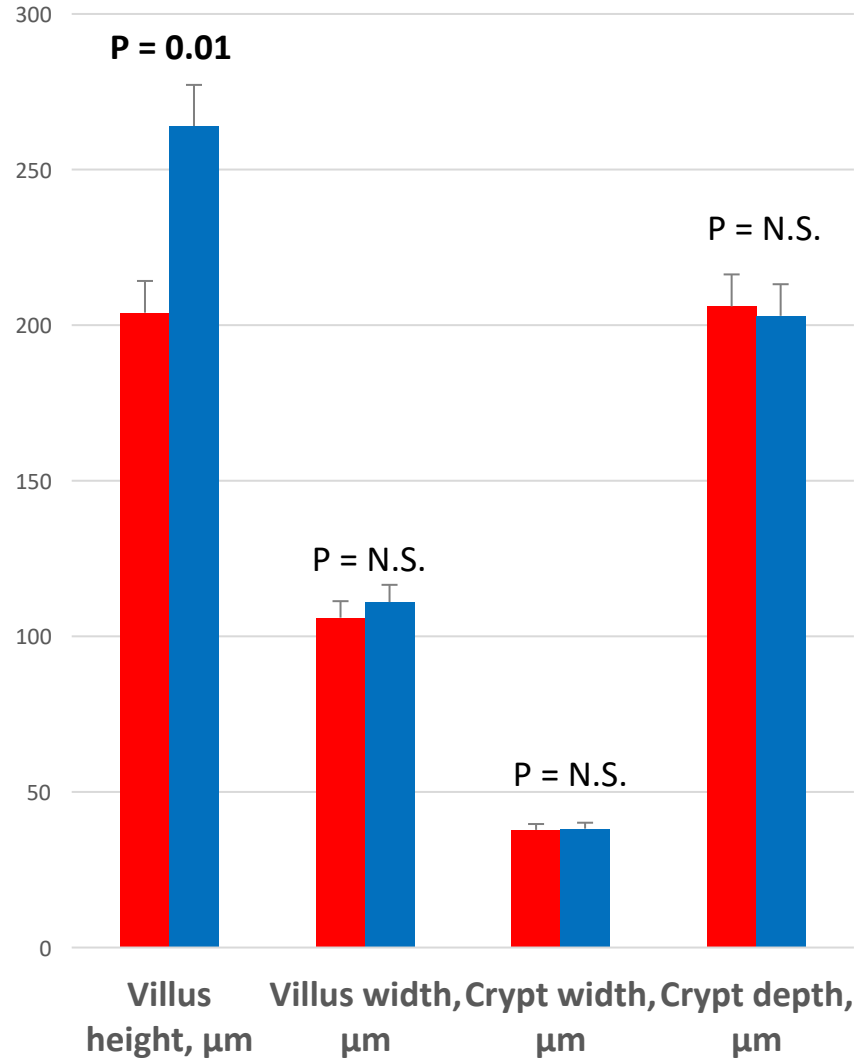


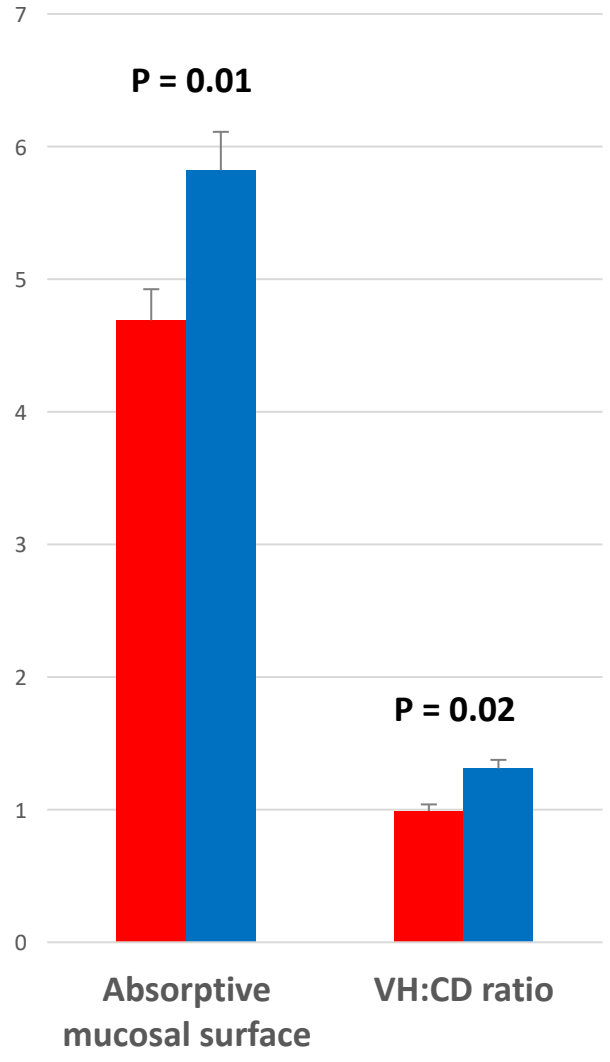




Fix, J.S., Cassady, J.P., Holl, J.W., Herring, W.O., Culbertson, M.S., See, M.T. (2010). Effect of piglet birth weight on survival and quality of commercial market swine. Livest. Sci. 132, 98–106. https://doi.org/10.1016/j.livsci.2010.05.007

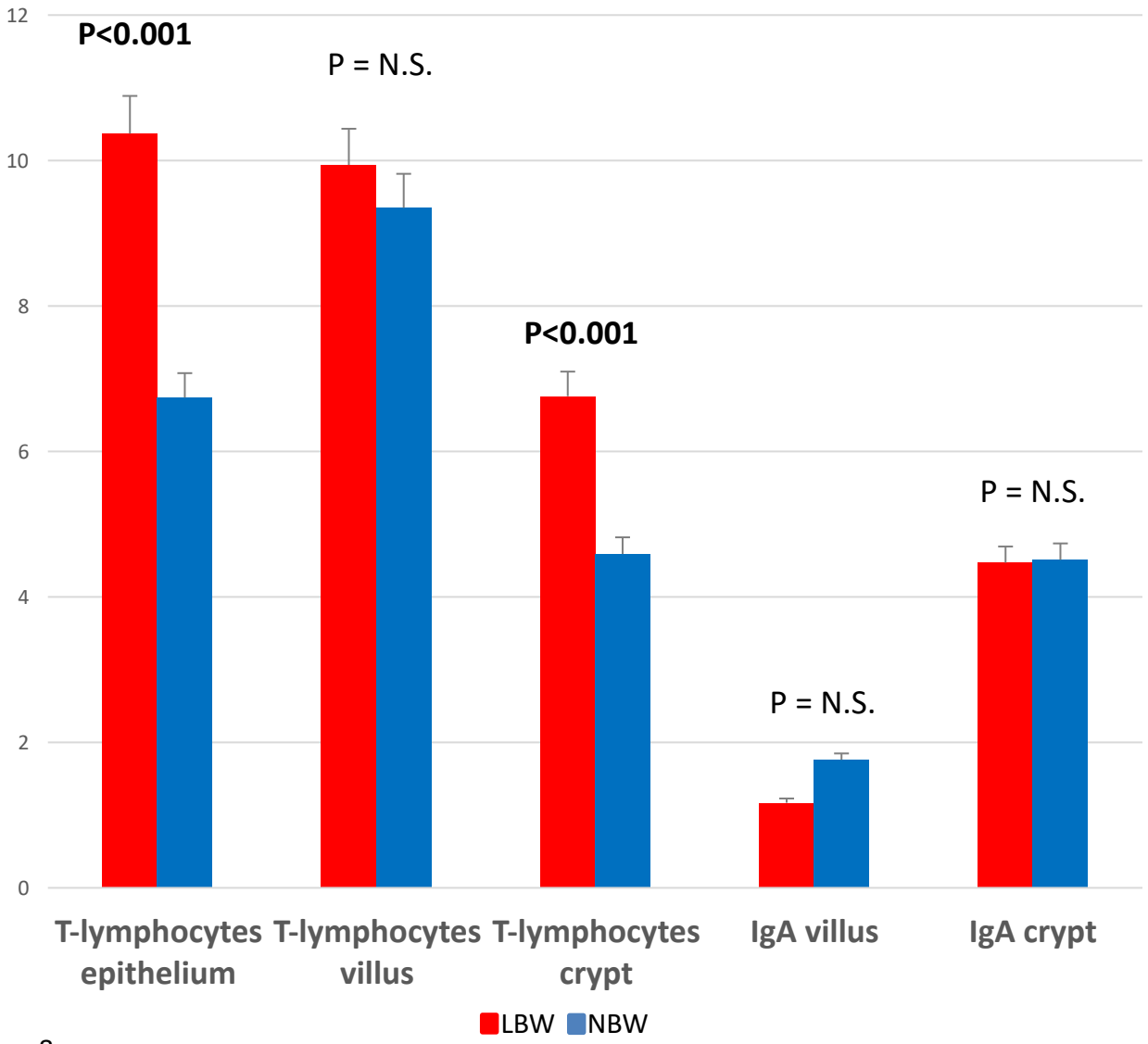
Results: Morphometric analysis at d21

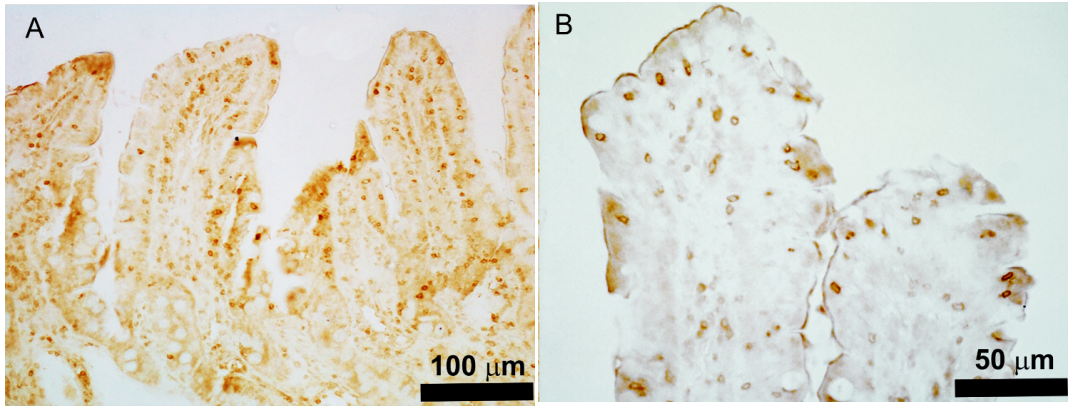




- No differences at **d9**
- at **d21** LBW piglets had lower villus height, VH:CD ratio, less absorptive mucosal surface.
- Low BW linked to reduced intestinal absorption in piglets.

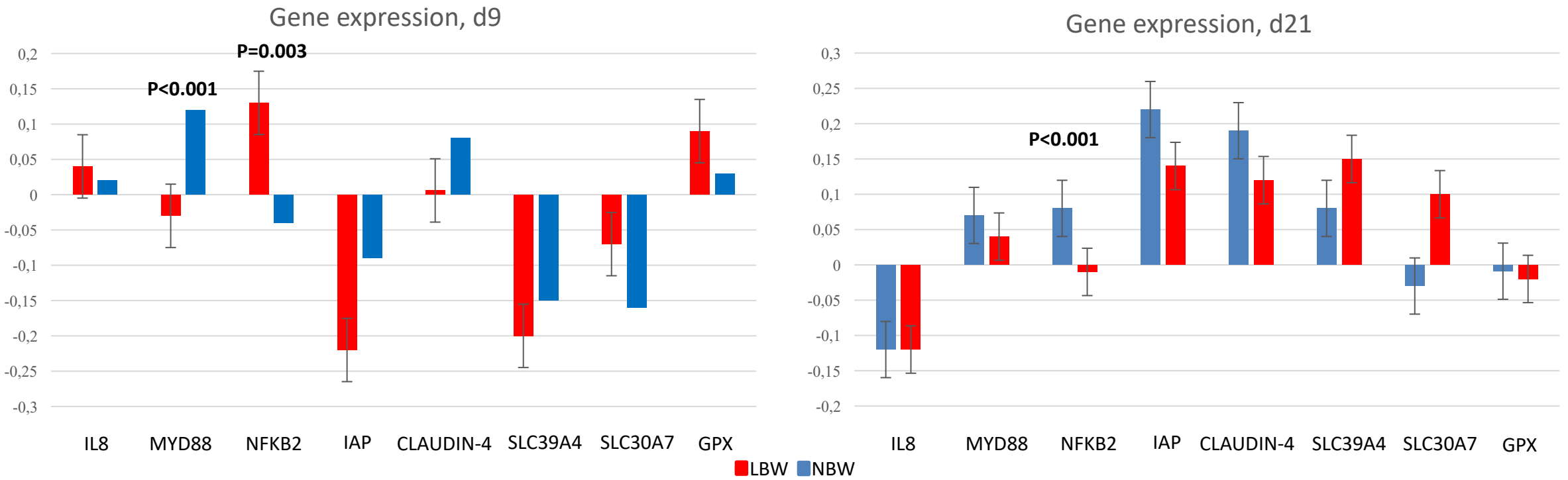
Results: Immmunohistochemistry at d21





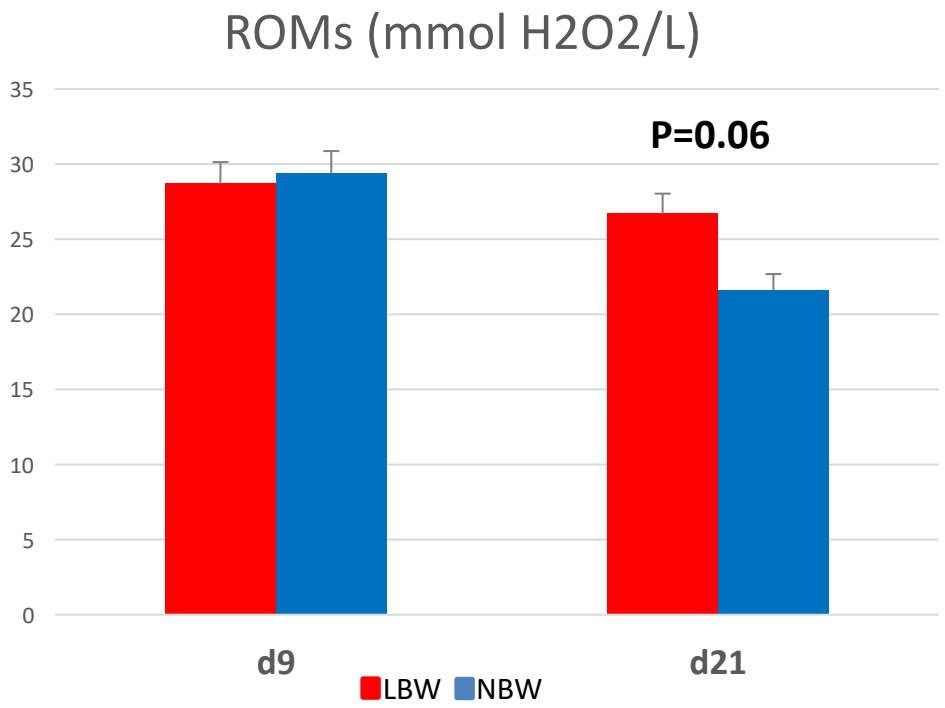
- No differences at **d9**
- LBW piglets had more intra-epithelial T-cells at d21
- Higher T-cell increase in LBW piglets might be due to slower recovery from the acute inflammatory phase

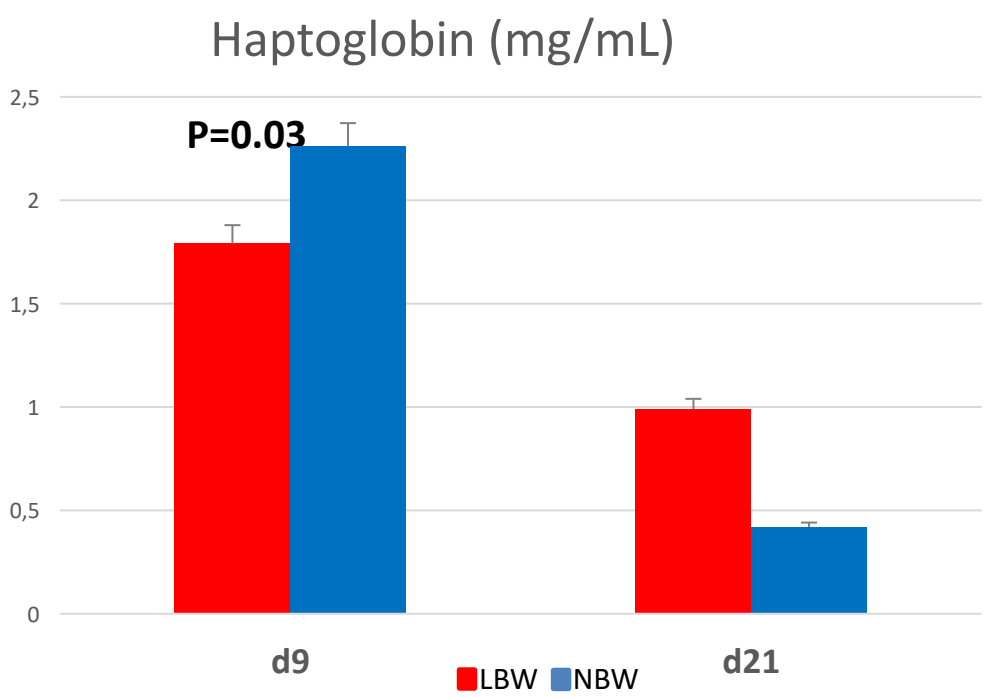
Results: Gene expression in jejunum mucosa



- NFKB2 gene expression consistently higher in LBW piglets, indicating oxidative stress activation and inflammation.
- MYD88 expression as well as other genes related to the innate immunity activation were downlregulated in piglets with a low weight gain (Lessard et al. 2018)

Results: Blood markers

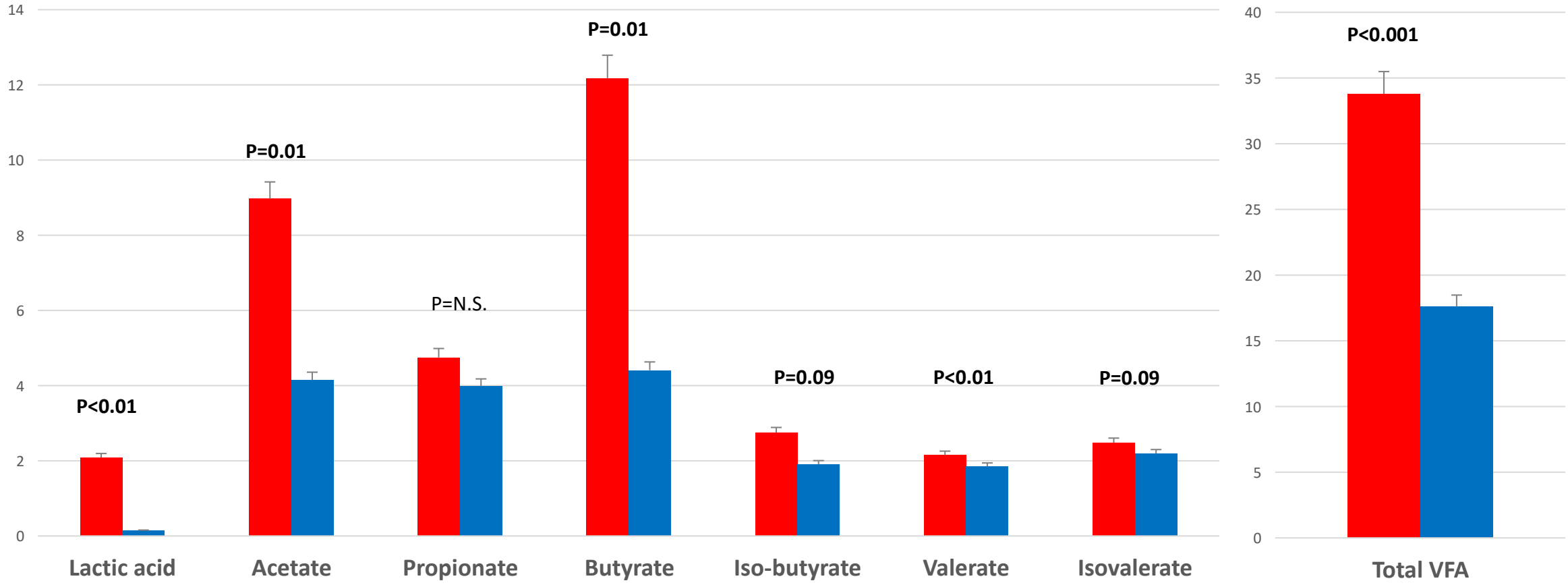




- Higher ROMs in LBW piglets at d21, together with the higher jejunal expression of *NFKB2* observed, at both d9 and d21, can indicate the activation of oxidative stress-related pathways

- A possible explanation for the higher Hp in the blood of NBW piglets could be linked to higher antioxidant activity via the prevention of lipid peroxides; as a greater percentage of adipose tissue and fatty acid circulation could have been present in this category of pigs.

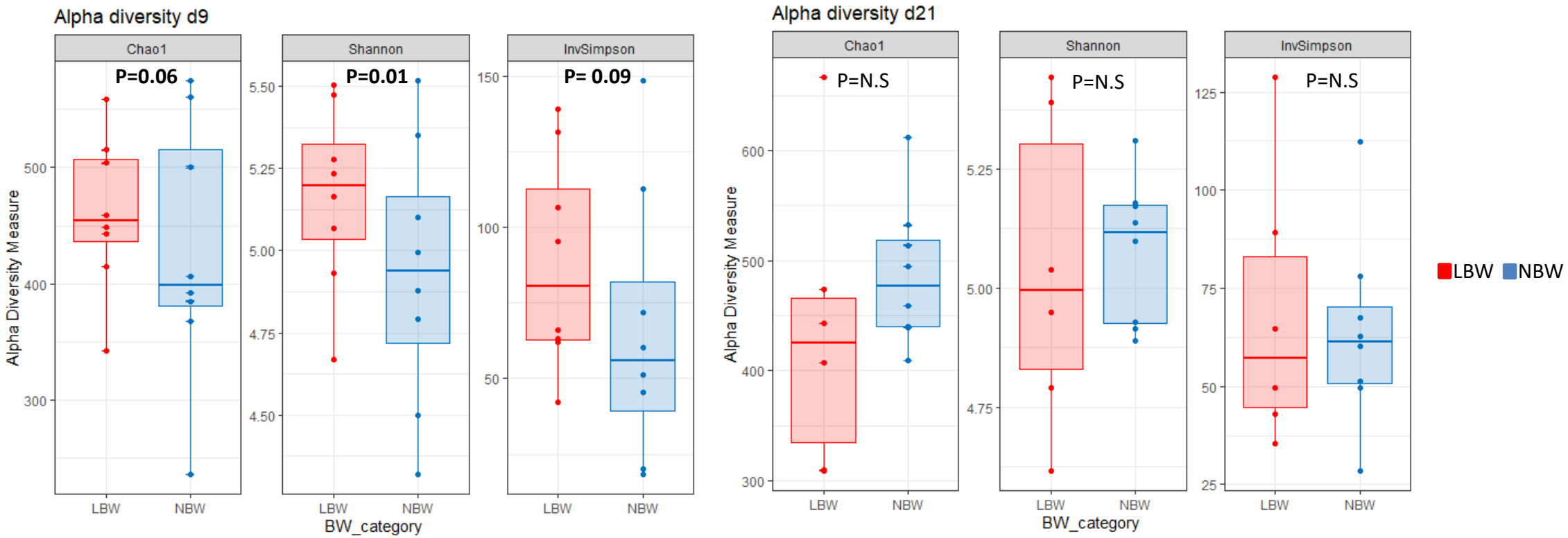
Results: Microbial activity at d21



- No differences ad **d9,** higher SCFA concentrations in LBW piglets' colons at **d21**.
- Similar SCFAs modulation was obsevred in preterm and NEC piglets (Thymann et al.,2009) (Di Lorenzo et al., 1995).
- That are caracherized to a reduced nutrient absorption that led to increased substrate for bacterial fermentation.

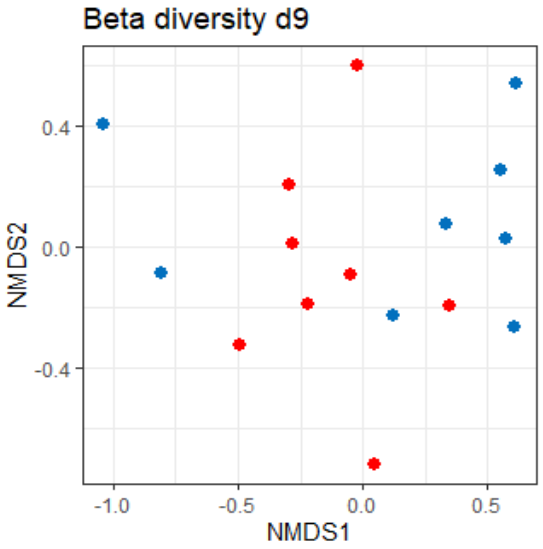
Di Lorenzo, M., Bass, J., Krantis, A. (1995). An intraluminal model of necrotizing enterocolitis in the developing neonatal piglet. J. Pediatr. Surg. , Papers Presented at the 26th Annual Meeting of the 30, 1138–1142. https://doi.org/10.1016/0022-3468(95)90006-3; Thymann, T., Møller, H.K., Stoll, B., Støy, A.C.F., Buddington, R.K., Bering, S.B., Jensen, B.B., Olutoye, O.O., Siggers, R.H., Mølbak, L., Sangild, P.T., Burrin, D.G. (2009). Carbohydrate maldigestion induces necrotizing enterocolitis in preterm pigs. Am. J. Physiol. Gastrointest. Liver Physiol. 297, G1115–G1125. https://doi.org/10.1152/ajpgi.00261.2009

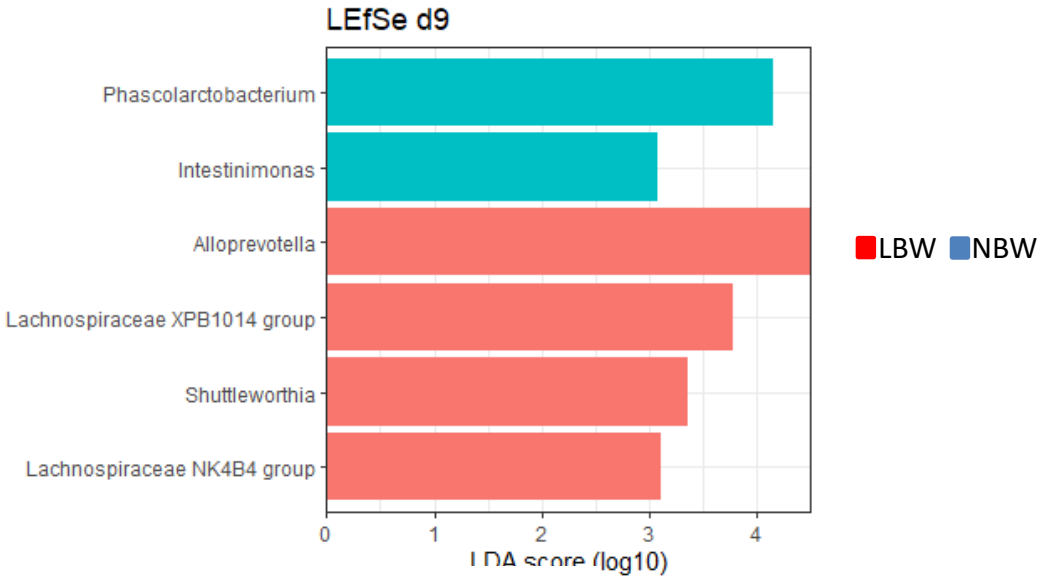
Results: Microbial Profile

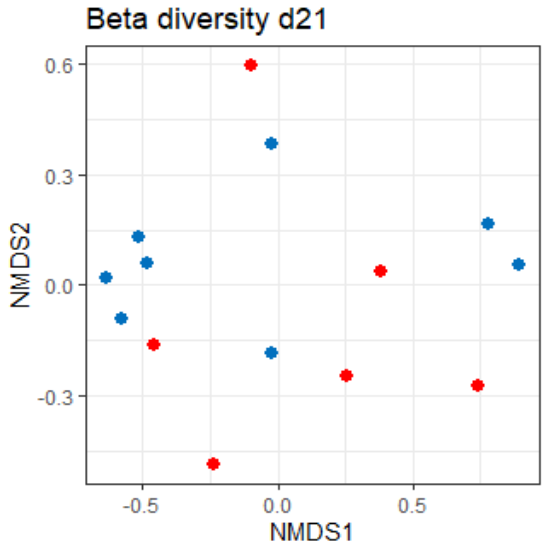


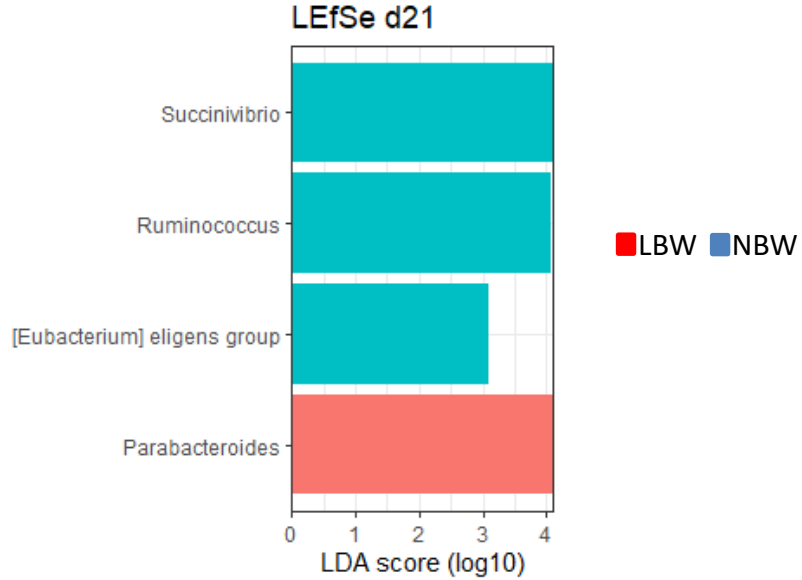
- The alpha diversity indices suggested that the LBW piglets had greater species diversity as compared with the NBW piglets at d9 but not at d21 post-weaning

Results: Microbiota profile









- No differences in the beta diversity at d0 and d21
- Lachnospiraceae XPB1014 group, Lachnospiraceae NK4B4 group, *Shuttleworthia* and *Alloprevotella* were higher in the LBBW piglets
- It is interesting to note that, in the earlier study of Huang et al. (2020), both the Lachnospiraceae XPB1014 group and the Lachnospiraceae NK4B4 group were found to be higher in the LBW piglets

Huang, S.-M., Wu, Z.-H., Li, T.-T., Liu, C., Han, D.-D., Tao, S.-Y., Pi, Y., Li, N., Wang, J.-J. (2020). Perturbation of the lipid metabolism and intestinal inflammation in growing pigs with low birth weight is associated with the alterations of gut microbiota. Sci. Total. Environ. 719, 137382. https://doi.org/10.1016/j.scitotenv.2020.137382

Final consideration

- LBW can have an a long term impact on the gut mucosal structure, immunity and inflammatory and oxidative status of the piglets
- This alteration can compromise microbial settlements and SCFA production.
- LBW piglets seems to recover slowly to the weaning transition compared to NBW pigs.
- Appropriate nutritional strategies should be considered for LBW pigs.

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Lyon, France - August 28th / September 1st, 2023

Thanks for your attention!