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Maternal intake of resveratrol can help piglets resist early weaning stress

Under commercial conditions, early weaning in pigs involves abrupt separation from sows, resulting in a sudden move to a new environment at a much younger age than would occur in natural conditions. Weaning is a critical period in pigs because of the immediate, transient reduction in food intake, resulting in severe undernutrition and growth inhibition, which consequentially inhibits various aspects of small intestinal architecture and function, leading to gut inflammation and diarrhea. Over the past several decades, antibiotics have been effectively used to treat diarrhea in young animals during the weaning transition. However, excessive use of antibiotics has accelerated the emergence of multidrug-resistant microbes, which has been an emerging threat to human and animal health. Thus, identification of alternatives to antibiotics and development of nutritional regulation measures to alleviate weaning stress. Maternal nutrition has shown benefits such as improvements to the immune status, intestinal microflora, and gastrointestinal health of offspring, which may reduce or alleviate weaning-associated intestinal dysfunction and diarrhea. Resveratrol has generated intense scientific and public interest in recent years, mainly because of its widely reported anti-aging, antioxidant, and anti-inflammatory properties. In our recent work, we explored the effects of maternal dietary resveratrol supplementation during pregnancy and lactation on the intestinal inflammation and diarrhea status of offspring during weaning in pigs.

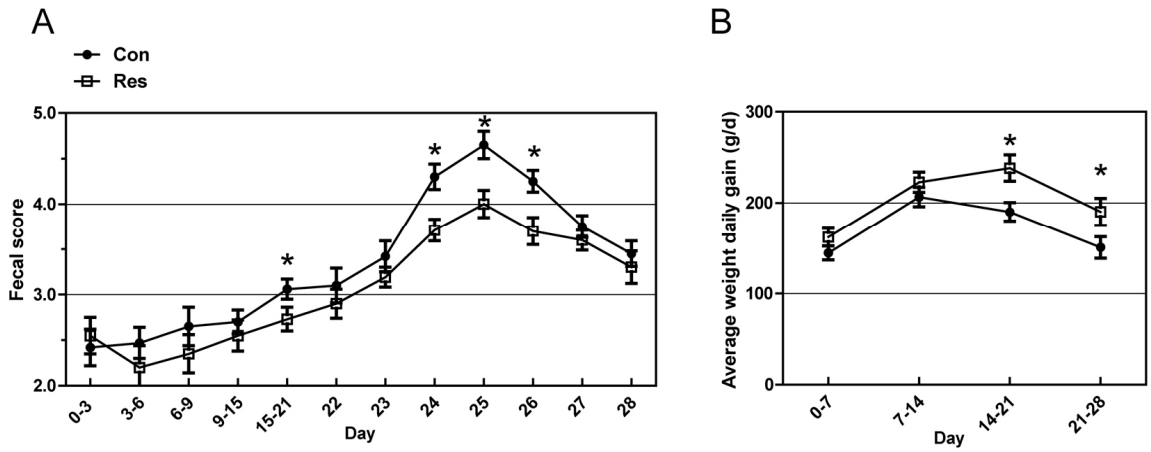

Fig. 1. Fecal score and average daily weight gains of piglets. (A) Fecal score. (B) Average daily weight gains. Con, control treatment; Res, resveratrol treatment. Piglets were weaned at 21 days after birth. All values are expressed as the means ± SEM (n = 20). *P < 0.05.

In this study, 40 multiparous sows were bred with semen from a pool of Landrace boars. Sows were segregated into two dietary treatments 20 days after breeding as follows: 1) control sows fed a basal diet (control treatment (Con), n = 20) and 2) treatment sows fed a basal diet supplemented with 300 mg/kg resveratrol for 20 days after breeding through gestation and lactation (resveratrol treatment (Res), n = 20). The growth performance, Fecal score, intestinal structure, intestinal inflammatory status of piglets during weaning period were examined. In additon, RNA-seq analysis was performed to measure intestinal gene expression and 16S rRNA gene sequencing was performed to evaluate the microbiota composition in feces.

We found that the fecal scores of piglets were reduced by maternal dietary resveratrol during days 15-21 after birth and days 3-5 post-weaning, indicating the diarrhea of piglets was alleviated (Fig. 1A). The average weight daily gains of piglets during days 1-7 post-weaning were increased by maternal dietary resveratrol (Fig. 1B), which indicated that maternal dietary resveratrol is beneficial for the growth performance of piglets. The villus height and villus/crypt ratio of the jejunum in weaning and post-weaning piglets were increased by maternal dietary resveratrol. In addition, the IL-1β levels in post-weaning piglets were reduced by maternal dietary resveratrol. The IL-6 and TNF-α levels in both weaning and post-weaning piglets were decreased by maternal dietary resveratrol. These results indicated that Maternal intake of resveratrol can help piglets resist early weaning stress.

Furthermore, RNA-seq analysis identified 189 and 139 differentially expressed genes (DEGs) in weaning and post-weaning piglets, respectively. Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway analysis showed that DEGs were enriched for the T cell receptor, primary immunodeficiency, mitogen-activated protein kinase (MAPK) and Ras signaling pathways in weaning piglets and for the cytokine-cytokine receptor interaction pathway and metabolism-related pathways in post-weaning piglets. In weaning piglets, maternal dietary resveratrol increased the proportion of butyrate-producing bacteria, such as *Flavonifractor*, *Odoribacter* and *Oscillibacter*, as determined by 16S rRNA sequencing (Fig. 2).

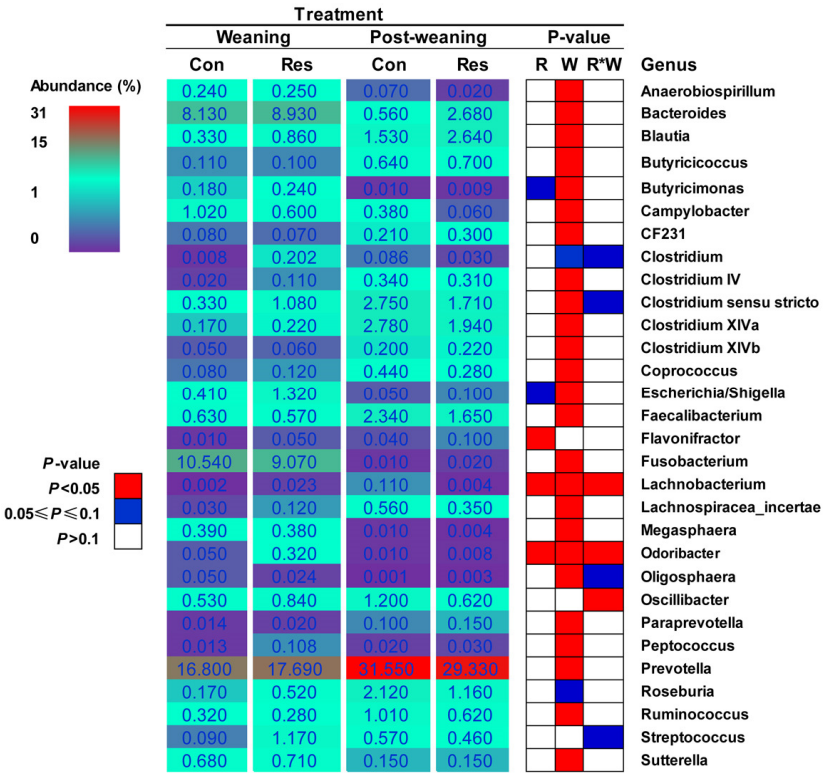

Fig. 2. Fecal microbiota at the genus level affected by maternal dietary resveratrol and/or weaning. All values are expressed as the means ± SEM (n = 5-6). Con, control treatment; Res, resveratrol treatment; R, main effect of resveratrol; W, main effect of weaning; R × W, interaction between resveratrol and weaning.

In summary, this study found that maternal dietary resveratrol supplementation can help offspring resist early weaning stress and demonstrated that maternal dietary resveratrol can alleviate weaning-associated diarrhea and intestinal inflammation as well as improve the intestinal morphology in piglets during weaning transition, potentially due to the modulation of intestinal gene expression and microbiota.

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