LIÈGE université
Gembloux
Agro-Bio Tech

Le Corps professoral de

Gembloux Agro-Bio Tech - Université de Liège vous prie

de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

**Madame CHEN Yuxia,**

**Titulaire d'un master's degree in agronomy,**

présentera en vue de l'obtention du grade et du diplôme de

**DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,**

le 1er juin 2022, à 10h précises (personne ne sera admis après cette heure),

en l'auditorium ZT1 (Bât. 1),

Passage des Déportés, 2, à 5030 GEMBLOUX

et en visioconférence.

Cette dissertation originale a pour titre :

« The Effects of Xylo-Oligosaccharides on Gut Barrier Function, intestinal microbiota and Growth Performance in Weaned Piglets ».

**Le jury est composé comme suit :**

Président : Prof. J. BINDELLE, Professeur ordinaire,
Membres : Prof. Y. BECKERS (Promoteur), Prof. H. ZHANG (Copromoteur - CAAS, Chine), Prof. M. LAITAT, Prof. M. SCHROYEN, Prof. N. EVERAERT (KU Leuven).

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**Summary**

Weaning piglets in modern swine industry is often challenged by post-weaning stresses including dietary, social, and environmental changes. These stresses result in increasing disease and mortality risks such as post-weaning diarrhea. This also raises tremendous physiological, immunological and microbiological changes in the piglet's intestines. To promote animal growth and prevent infections, antibiotics are widely used in weaned piglets. Unfortunately, the usage of antibiotics as feed additives for long periods in animal diets can lead to antibiotic resistance problem and high residue levels in animal products. Since the quest for safer and healthier meat was remarkably increased in recent time, the use of nutritional feed additives is considered as promising strategy to alleviate intestinal disturbances around weaning. Prebiotics from the agricultural by-products are nutrients that have the potential to considerably influence the physiology of the whole body and, consequently, health, and well-being. Xylo-oligosaccharides (XOS) are considered as functional oligosaccharides and have great prebiotic potential. However, the optimal XOS supplementation dosage used in the diet of weaned piglets is still unknown. Therefore, the aims of the research described in this thesis are to (1) select an optimal XOS supplementation dosage that improve the growth performance, serum parameters, small intestinal morphology, intestinal mucosal integrity, and immune function in weaned piglets. (2) investigate whether optimal XOS supplementation dosage as potential replacements for antibiotic optimizes the gut morphology, gut microbial and metabolic composition of weaned piglets.

For the first objective, a total of 240 weaned piglets with an average body weight (BW) of 8.82 ± 0.05 kg (28 d of age) were assigned randomly to 4 dietary treatments in a 28-d trial, including a control diet (CON), 3 diets with XOS supplementation at the concentration of 100, 500 and 1000 mg/kg (XOS100, XOS500, and XOS1000). There were 4 replicates per treatment with 15 pigs per pen. The different XOS dose groups showed a quadratic effect on BW on day 28, ADG, and G:F day 1 to -28 of piglets ($P < 0.05$). From d 15 to 28, ADG of pigs fed the XOS500 diet was higher ($P < 0.05$) than pigs fed the CON diet. During the overall period (d 1 to 28), pigs fed the XOS500 diet had a higher BW, ADG and G:F than pigs fed the CON diet ($P < 0.05$). In addition, compared with the CON group, the XOS500 group had significantly higher serum antioxidant capacity on d 14 and 28. Supplementation of XOS500 to the feed significantly improved intestinal morphology in the jejunum and ileum in comparison with the CON and XOS1000 group. Moreover, the XOS500 group significantly elevated the expression levels of Occludin and zonula occludens protein-1 (ZO-1) in the ileum compared to the CON group. The ileal proinflammatory cytokine expression levels in the XOS100 and XOS500 group were markedly lower than in the CON group. In contrast, the ileal IL-10 mRNA expression levels were remarkably higher in the XOS500 than CON group. The results indicated that the optimal level of xylo-oligosaccharides have a beneficial effect on growth performance by improving serum antioxidant defense system, serum IgG, small intestinal structure and intestinal barrier function in weaned piglets.

Secondly, we investigate whether optimal XOS supplementation dosage as potential replacements for chlortetracycline optimizes the gut morphology, gut microbial and metabolic composition of weaned piglets. A total of 180 weaned piglets were randomly allocated to three treatments for 28 days, as follows: control group (basal diet, CON), basal diet with 500mg/kg (XOS500) XOS, and positive control (basal diet with 100 mg/kg chlortetracycline, CTC). Compared with the CON group, the piglets in the XOS500 group improved growth performance during days 1–28 ($P < 0.05$). High-throughput 16S rRNA gene sequencing revealed distinct differences in microbial compositions between the ileum and cecum. XOS500 supplementation significantly increased the bacterial diversity. However, CTC treatment markedly reduced the microbial diversity ($P < 0.05$). Meanwhile, XOS500 supplementation in the diet significantly increased the abundance of Lactobacillus genus compared to the CON and CTC group in the ileum and cecum ($P < 0.01$), whereas the level of Clostridium_sensu_stricto_1, Escherichia-Shigella and Terrisporobacter genus in the XOS500 group were markedly lower than the CON and CTC group ($P < 0.05$). In addition, dietary supplementation with XOS500 significantly increased the total short-chain fatty acids, propionate and butyrate concentrations and decreased the acetate concentration compared to the CON group in the cecum ($P < 0.05$). The results indicated that dietary supplemented with XOS500 could enhance specific beneficial microbiota abundance and decrease harmful microbiota abundance to maintain the structure of the intestinal morphology and improve growth performance of weaned piglets. Thus, XOS may potentially function as an alternative to in-feed antibiotics in weaned piglets in modern husbandry.

In summary, this thesis demonstrated that XOS supplementation could function in a dose-dependent manner. The optimal XOS supplementation dosage could improve serum antioxidant capacity, immune function, maintain intestinal barrier function, and enhance specific beneficial microbiota abundance and decrease harmful microbiota abundance, changes SCFA production which resulted in maintain the structure of the intestinal morphology and improve growth performance of weaned piglets. Thus, XOS may potentially function as an alternative to in-feed antibiotics in weaned piglets in modern husbandry. This work may not only provide insight into strategies for improving the status of weaned piglets targeting the gut microbiota, but also help us to develop a complementary understanding of effective feed additives for weaned piglet health.