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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

Monsieur LI Bing,

Titulaire d'un diplôme de *postgraduate studies majoring in animal nutrition and feed science*,

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

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 5 décembre 2018, à 16h30 précises (personne ne sera admis après cette heure),

en l'auditorium ZT1 (Bât. 1),

Passage des Déportés, 2, à 5030 GEMBLOUX.

Cette dissertation originale a pour titre :

« Early life programming by prebiotics or ingredients rich in non-starch polysaccharides in broiler chickens and pigs: effects on growth performance, intestinal maturation and colonization ».

Le jury est composé comme suit :

Président : Prof. C. BLECKER, Professeur ordinaire,
Membres : Prof. N. EVERAERT (Promoteur), Prof. J. BINDELLE (Copromoteur), Prof. L. WILLEMS, Dr B. TAMINIAU, Prof. J. MICHIELS (UGent), Prof. P. TREVISI (University of Bologna, Italy).

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Summary

Prebiotics or ingredients rich in non-starch polysaccharides (NSPs) are often used to improve intestinal health aiming to reduce the use of antibiotics in today's intensive management farms. These ingredients display prebiotic effects when fermented in the large intestine. The maturation and colonization of the intestine starts soon after birth, and can be programmed by early life interventions, affecting their development even until adulthood. However, the effect of fermentable ingredients applied in early life is so far poorly investigated. Therefore, we chose 2 popular fermentable ingredients: inulin, a mixture of oligomers and polymers of fructose, and wheat bran, a feed ingredient containing high levels of NSPs to investigate their effects on growth performance, intestinal maturation and colonization during the early life in broiler chickens and pigs. In addition, we aimed to evaluate whether the early programming of these ingredients resulted in a lasting effect, when the supplementation was stopped. Moreover, we conducted a collaboration with a company to test 4 potential additives (galacto-oligosaccharides, acidic oligosaccharides, colostrum derivative, prototype oligosaccharides) in suckling piglets.

Firstly, the inulin and wheat bran were provided to broiler chickens separately or in combination to study their effects during the starter period (**Chapter IIa**) or finisher period (**Chapter IIb**). Per dietary treatment (inulin, wheat bran or the combination), chickens received this ingredient either during the entire rearing period or during the starter period only, aiming at investigating lasting effects of a temporary supplementation. The inulin had a greater ability to shape the microbial fermentation during the starter period, as seen by **Chapter IIa**. The inclusion of 2% inulin in the diet might have been too high for chickens as it did not affect body weight (BW) and gut morphology positively during the entire life. The beneficial effect on gut morphology when the supplementation was stopped might point to this over-dose too. In contrast, the beneficial effect of wheat ban was mainly on BW during the starter period, and this beneficial effect was lasting until slaughter age, suggesting that wheat bran might be a favourable ingredient during the starter period. It also reduced some potential pathogenic bacteria during the finisher period. The combination of inulin and wheat bran not only demonstrated certain properties of the individual supplemented ingredients, but also showed a synergistic effect, seen by its improved results of BW and gut morphology. Lasting effects of inulin and wheat bran were absent in our study, except for the BW in the wheat bran group.

Secondly, we investigated the effect of inulin and wheat bran in pigs. In a first attempt, the inulin and wheat bran were provided to suckling piglets in creep feed (**Chapter IIIa**). However, a low and uncontrolled intake of creep feed was observed, perturbating the interpretation of the results. Therefore, in a proof-of-concept experiment, in **Chapter IIIb**, different amounts of inulin (IN-0.5: 0.5 g/d inulin at birth, increasing weekly with 0.5 g/d inulin and IN-0.75: 0.75 g/d inulin at birth, increasing weekly with 0.75 g/d inulin) were provided to piglets orally during the suckling period. Thereafter, piglets were also reared during 3 weeks after weaning to evaluate the lasting effect induced by the early supplementation with inulin. A dose-effect of inulin was observed. Only IN-0.5 displayed prebiotic effects, improving the BW, the gut morphology, the SCFA profile in the large intestine and selected colonic bacteria. But both inulin-groups reduced gene expressions of some inflammatory markers to help piglets against inflammation. Only the BW and gut morphology were found to have a lasting effect when supplementation was stopped, but it could be just an accumulation of early advantages.

Thirdly, we performed an experiment in suckling piglets with a company to test 4 potential additives, which belonged to oligosaccharides- and colostrums-derivatives (**Chapter IV**). All these ingredients improved the BW of piglets during the suckling period, but through the measurement of gene expressions of cytokines (acidic oligosaccharides and prototype oligosaccharides) and microbiota profile (galacto-oligosaccharides and prototype oligosaccharides), we did not observe any alteration.

In summary, this thesis increased the understanding of the early use of inulin, wheat bran, as well as the other potential prebiotic additives in broiler chickens and pigs, especially their effects during early life. The supplementation of inulin and wheat bran improved growth performance and intestinal parameters in broiler chickens and pigs, but in a dose-dependent way, where an excess amount did not affect them positively. In addition, their prebiotic effects relied on the administration of inulin and wheat bran directly, suggesting no or a weak lasting effect. As for the potential additives of oligosaccharides- and colostrums-derivatives, all these ingredients improved the BW of suckling piglets, but did not affect immune response and microbial fermentation