Instytut Zootechniki Państwowy Instytut Badawczy

„Metabolizm lipidów i jego rola w regulacji rozwoju przewodu pokarmowego u prosiąt”

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INTRODUCTION: Fats are not only a concentrated source of dietary energy, but as a major component of cell membrane and highly biologically active compounds they may also regulate various important biological processes such as immune response, enzymes and membrane receptors activity or cell proliferation. However, the exact mechanism of action behind individual dietary fatty acids remains unknown and their metabolic fate is determined by their type, amount, structural characteristics and even period of supply, what might be related to the different catalytic efficiency of enzymes involved in their metabolism, especially pancreatic lipase. The fats in food consist mainly of a complex mixture of triglycerides which must be hydrolyzed in order to be absorbed by enterocytes. By regulating the hormonal responses and energy homeostasis of the body, fats may also affect the development of the gastrointestinal tract which may be of particular importance in conditions such as prematurity or post-weaning depression, when the structure and function of the gastrointestinal tract, and consequently the growth of the whole organism, is impaired. The observed changes in the structure of the gastrointestinal mucosa together with reduced secretory activity lead to a decrease in the absorptive area of the intestine and significantly impede the digestion and absorption of nutrients. Current nutritional recommendations for fat intake, both for preterm infants and weaned piglets, seem not to meet their high physiological needs and very often they lack of information on the most optimal level and type of fat in the diet.

RESEARCH AIM: The aim of the experiment I was to assess the effect of feeding with milk formula supplemented additionally with DHA and ARA oils containing fats pre-hydrolyzed *ex-vivo* with microbial lipase on fatty acids absorption, structural development of the gastrointestinal tract and growth parameters of newborn piglets as an animal model for human premature babies. In turn, the objective of experiment II was to evaluate the impact of fat source *differing* in *fatty acid profile* on performance, metabolic and hematological parameters, hypothalamic expression of genes involved in energy homeostasis and structural development of the gastrointestinal tract in weaned piglets.

MATERIALS AND METHODS: The experiment I was carried out on newborn piglets born 8 days before arrival, which mimics human babies born around 30 week of gestation. Piglets were inserted with gastric tube and jugular vein catheters to enable enteral feeding and frequent blood collections, respectively. After the adaptation period piglets were divided into two groups (n=14): control group fed non-hydrolyzed milk formula and PrEFIC group fed with milk

formula pre-hydrolyzed with microbial lipase. The milk formula consisted of donor milk with human milk fortifier and infant formula and was additionally supplemented with DHA and ARA oils. The hydrolysis was performed using digestive cartridge PrEFIC containing immobilized lipase of microbial origin that fits in-line with enteral feeding sets. Piglets' body weight and intake of milk formula was recorded daily throughout the study, blood samples were collected three times and stool samples were collected on the last day of study to analyze the fatty acid profile. After the 10-day experimental period, the piglets were sacrificed and brain and gastrointestinal tissue samples were collected for fatty acid profile and histological analysis, respectively. In addition, 4 premature piglets and 4 non-suckling newborns piglets were killed immediately after delivery for comparison purposes.

Experiment II was performed on 42-day old boars of 990 synthetic line, weaned at 28 days of age. The piglets were divided into 3 groups (n = 6): a control group fed a standard feed for weaned piglets; OL group fed a standard feed but supplemented with 10% of linseed oil; OP+F group fed a standard feed but supplemented with 10% of fractionated palm oil with selected phospholipids. The piglets were fed for 21 days and had *ad libitum* access to feed. Piglets' body weight and feed intake was recorded throughout the study. On the last day of study blood samples were collected for biochemical and hematological analyzes. Piglets were sacrificed and hypothalamus and gastrointestinal tract tissues were collected for gene expression and histological analysis, respectively.

CONCLUSIONS: Piglets born prematurely may be used as clinically relevant model for human newborns due to similarities in low birth weight, food intake volume, general gastrointestinal immaturity and low DHA and ARA plasma levels immediately after birth. Feeding with milk formula that contains fat predigested by microbial lipase results in increased plasma fat absorption followed by reduced fecal losses of critical LCPUFA already after 10-days of treatment. Moreover, *ex-vivo* hydrolyzation of fats positively affects the intestinal morphology of prematurely born piglets and the intestinal mucosa structure most closely resembles that of piglets born at the time. The use of the PrEFIC column improves also growth rates in preterm pigs, is safe and well tolerated, and thus enables the creation of functional milk formula that normalize LCPUFA status in preterm pigs in critical first weeks of postnatal development.

In turn, result of experiment II showed that increased amount of fat in diet of weaned piglets results in a range of metabolic changes that might be beneficial in terms of animals performance, leading to increased weight gains and decreased feed conversion ratio. Dietary fats affect not only the blood lipid profile but also the activity of many hormones involved in

energy homeostasis regulation, including leptin, ghrelin, insulin and thyroid hormones. Moreover, fatty acids seem to show a highly trophic effect on the gastrointestinal mucosa, resulting in positive changes in its structure, increased intestinal absorption area and consequently higher *nutrient* use *efficiency*.

In summary, the obtained results confirm that both the amount, type and physicochemical characteristics of fats have a significant and different impact on fatty acids absorption, metabolic response, as well as the structure of the gastrointestinal tract and growth of piglets. However, in order to be able to develop dietary guidelines for both premature infants and weaned piglets, further more extensive studies need to be undertaken to identify and understand the exact mechanisms involved in the regulation of lipid metabolism and its impact on gastrointestinal development and animal growth.