Effect of maternal glucoraphanin intake on chronic inflammation in the hypothalamus, cerebrum, and liver of high fructose-diet-fed rat offspring exposed to maternal undernutrition

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Ⅰ. Background

The fetal and neonatal environment is associated with subsequent development of diseases in adulthood (1). Maternal undernutrition during pregnancy and lactation can cause dyslipidemia, hyperglycemia which can affect different organs and cause metabolic disorders such as chronic liver disease, Type 2 diabetes, and hypertension in offspring during their adulthood (2, 3).

Fructose, a simple monosaccharide, is used as a sweetener in food and drinks. High dietary fructose is a major contributor to insulin resistance and metabolic syndrome, disturbing tissue and organ functions (4).

Glucoraphanin (GR) derived from broccoli, is a water soluble, relatively inert precursor of sulforaphane; the reactive isothiocyanate which has shown to be effective in different metabolic disorders such obesity, insulin resistance, and non-alcoholic fatty liver disease (NAFLD)(5). However, less is known about the effect of GR intake during lactation on the lipid and glucose metabolism in the adult rat offspring programmed by maternal protein restriction.

Ⅱ. Objectives

The aim of the present study was to explore the effect of maternal intake of GR-containing broccoli powder (BP) during lactation on lipid and glucose metabolism of high-fructose-diet fed male rat adult offspring born from dams with low or normal protein diets.

Ⅲ. Materials and Methods

The Animal Research Committee, Aomori University of Health and Welfare, approved this study and all experimental procedures were performed in accordance with the Institutional Guidelines for Animal Experimentation (Permission number: 21008). Pregnant rats received diets containing 20 % (Normal Protein; NP) or 8 % (Low Protein; LP) casein. While 0 or 0.74% BP containing NP diets (NP/NP or NP/ NP+BP) in Experiment (Expt.) 1 and 0 or 0.74% BP containing LP diets (LP/LP or LP/LP+BP in Expt. 2 were provided during lactation. At weaning, pups that received a diet of distilled water (W) or 10% fructose solution (Fr) were divided into six groups: NP/NP/W, NP/NP/Fr, NP/NPBP/Fr in Expt. 1 and LP/LP/W, LP/LP/Fr, LP/ LPBP /Fr in Expt. 2. The body weights, food intake, and water and fructose intake of pups post weaning (PW) were recorded. At week 13 after treatment, male pups were weighed, and blood samples were taken. The livers and adipose tissues (Epididymal Fat tissue; EFT and Perirenal Fat tissue PFT) were dissected and weighed. Glucose (Glc), triglyceride (TG), aspartate transaminase (AST), and alanine transaminase (ALT) in the plasma levels and hepatic TG levels were measured.

Ⅳ. Results and Discussion

1. Body weights

During gestation, the body weights of dams in NP and LP groups didn’t differ significantly. During

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lactation, there was no significant difference in the body weights of male pups per litter between NP/NP and NP/NPBP groups in Expt. 1, and between LP/LP and LP/LPBP groups in Expt. 2, respectively. After weaning, there were no significant differences in the body weights of between BP and Fr groups in both Expt. 1 and Expt. 2.

2. Food, water, and fructose intake

After weaning, the daily food intake of NP/NP/Fr was significantly lower than that of NP/NP/W group at all PW weeks. While it was higher in NP/NPBP/Fr than NP/NP/Fr group in PW 8 and 10 weeks in Expt.1. Similarly, the daily food intake was seen to be lower in LP/LP/Fr compared to LP/LP/W in PW8, 10, and 12 weeks while it was higher in LP/LPBP/Fr than LP/LP/Fr in PW8 in Expt. 2. In Expt. 1, the fructose intake was higher in NP/NP/Fr compared to NP/NP/W group in all PW weeks while it was higher in NP/NPBP/Fr than NP/NP/Fr in PW8 and PW12 week. Similarly in Expt. 2, the fructose intake was higher in LP/LP/Fr compared to LP/LP/W in PW8, 10, and 12 weeks while higher between LP/LPBP/Fr and LP/LP/Fr in PW5 weeks

3. Organ weights and hepatic function

The relative weight of livers and PFT were found to be higher in NP/NP/Fr group compared to NP/NP/W group in Expt. 1. However, no significant differences were found between BP and Fr groups in Expt.1. In Expt.2, the relative weight of livers was found to be decreased in LP/LPBP/Fr compared to LP/LP/Fr. No statistical significance was observed with weights of other organs in these groups.

The plasma AST and ALT level in LP/LPBP/Fr were lower than those in LP/LP/Fr. However, no significant differences in AST and ALT level were found among the three groups in Expt.1.

4. Effect of BP intake during lactation on plasma Glc and TG contents and hepatic content.

The plasma Glc and TG levels in NP/NP/Fr and NP/NPBP/Fr were significantly higher than that NP/NP/W. No significant differences were observed between NP/NP/Fr and NP/NPBP/Fr in Expt. 1. Likewise, the plasma Glc and TG levels in LP/LP/Fr and LP/LPBP/Fr were significantly higher than those in LP/LP/W in Expt. 2. There was no significant difference in the Glc levels between LP/LP/Fr and LP/LPBP/Fr, whereas the plasma TG levels in LP/LPBP/Fr were significantly lower than that in LP/LP/Fr. Although hepatic TG levels were observed to be higher in BP groups compared to Fr groups, they were not found to be statistically significant in both Expt.1 and Expt. 2, respectively.

V. Conclusion

Maternal BP intake during lactation may be involved in the alterations in weights of liver, adipose tissue as well as lipid, glucose metabolism, and liver function parameters of adult male offspring fed on high fructose diet.

VI. References

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VII. Presentation

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