学位論文審査の要旨

博士の専攻分野の名称　博士（農学）　氏　名　Aphichat Trakooncharoenvit

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学位論文題名

Studies on bioavailability of quercetin by combined feeding of α-glycosyl-isoquercitrin and soybean fiber, and the protective role against glucose intolerance in rats

(ラットにおけるα-グルコシルイソクエルシトリンと大豆繊維の共摂取によるケルセチンの生物学的利用能向上とそれによる耐糖能障害の予防に関する研究)

This thesis comprises 82 pages, 16 figures, 9 tables, and 4 chapters with 3 reference literatures.

Quercetin is a naturally occurring flavonol found abundantly in vegetables and fruits as single- or multi-glycosylated forms. Dietary quercetin and its glycosides reportedly have a promising anti-diabetic effect. Conversely, this beneficial effect was limited due to poor intestinal absorbability and the degradation by commensal bacteria. Improving its bioavailability could be valuable to further promote quercetin's beneficial effects on the body. A previous study reported that a non-digestible oligosaccharide promoted intestinal quercetin absorption. This raises the possibility of improvement of quercetin bioavailability by some kinds of dietary fibers. Thus, the objective of the study was to investigate the ability of dietary fibers on promoting the bioavailability of quercetin, and whether certain combination of quercetin and a dietary fiber improves quercetin bioavailability and glucose tolerance in rats fed with an obesogenic diet.

The first experiment aimed to examine the effects of several dietary fibers on the bioavailability of the water-soluble quercetin glycosides, α-glycosyl-isoquercetin (AGIQ). Male Wistar/ST rats were fed a test diet containing 0.7% AGIQ with or without 5% of each dietary fiber (pectin, soybean fiber, and guar gum) for 9 weeks. The quercetin bioavailability and degradation were evaluated every two weeks by collecting plasma, urine, and feces. At weeks 6 and 8, the soybean fiber supplemented group showed higher concentrations of total quercetin derivatives in plasma and urine, than control treatment. Intestinal degradation of quercetin, calculated from differences between aglycone ingestion and the sum of urinary and fecal excretion, was suppressed by dietary fiber supplementations. From this experiment, soybean fiber showed the best potential to enhance the quercetin bioavailability after a long-term feeding, which may promote the beneficial effects of quercetin.

The second experiment aimed to clarify whether the combined feeding of soybean fiber and AGIQ could enhance quercetin bioavailability, subsequently affecting glucose metabolism in a diet-induced obese rat model. Male Wistar-ST rats were individually fed a AIN-93G diet as the control (C), a high-fat high-sucrose (30% fat and 40% sucrose; H) diet, H with soybean fiber (HS) diet, H with AGIQ (HQ) diet, or H with both soybean fiber and AGIQ (HSQ) diet for 9 weeks. Plasma, urine, feces, and tissue samples were similarly collected as the first experiment. Meal tolerance tests (MTTs) were conducted every 4 weeks of the feeding period to assess postprandial responses of glucose, insulin, and a gastrointestinal hormone, glucagon-like peptide-1 (GLP-1). The HSQ group had higher levels of total quercetin derivatives in plasma, feces, and cecal contents than the HQ group at the late period of the experiment. These results demonstrated the ability on enhancing quercetin bioavailability of soybean fiber under an obesogenic dietary condition, possibly via promoted cecal fermentation. In addition, the HSQ group had lower postprandial glycemia than the H group, indicating the improvement of glucose tolerance by the combination of quercetin and soybean fiber. Furthermore, a significantly positive correlations were observed between plasma GLP-1 concentrations and plasma quercetin derivative concentrations, suggesting promotive effect of quercetin on GLP-1 secretion.

In conclusion, contentious ingestion of soybean fiber can increase quercetin bioavailability in rats, possibly through enhancing intestinal fermentation. The combination of soybean fiber and AGIQ could be beneficial for reducing the risk of glucose intolerance, possibly involving enhanced quercetin bioavailability and GLP-1 secretion. These findings might help to establish a new diet composition that combines functional flavonoids with dietary fiber to minimize the risk of diabetes and other related diseases.

Therefore, we acknowledge that the author (Aphichat Trakooncharoenvit) is qualified to be granted the Degree of Doctor of Philosophy in Agriculture from Hokkaido University.