

## 学位論文題名

## Satiating effect of dietary plant proteins, peptides and the involvement of gastrointestinal hormones in rats

（ラットにおける、植物由来の食品たんばく質、ペプチドによる  
消化管ホルモン分泌を介した食欲調節に関する研究）

## 学位論文内容の要旨

Appetite control becomes a focus for nutrition research and protein is one of the most satiating macronutrients. Postprandial satiety is triggered by gut hormones (such as CCK produced in the proximal intestine and/or GLP-1, PYY produced in the distal intestine) secreted from intestinal endocrine cells (enteroendocrine cells) in response to nutrient ingestion. However, the satiating potencies of different protein sources are not well known. Purposes of the present study were to examine the satiating effect of multiple plant proteins/peptides, and to investigate the involvement of gut hormone secretion by using *in vivo* (rats) and *in vitro* (cell cultures) models.

*Satiating effect of potato extract and involvement of CCK secretion*

Potato is one of the most satiating foods. To investigate the satiating effect of potato extract containing potato proteins, food intake was measured after oral preload of potato extract in 18-hr-fasted rats. CCK secretion in response to potato extract was examined in portal cannulated rats and in CCK-producing enteroendocrine cell line STC-1.

Oral preload of potato extract reduced subsequent food intake in rats, and the effect was greater than a soy protein hydrolysate and casein. The suppressive effect of potato extract on food intake was attenuated by treatment with a CCK receptor antagonist. Duodenal administration of potato extract increased plasma CCK level in anesthetized rats, and CCK secretion was induced by potato extract in STC-1 cells. These results indicate that potato extract suppresses the food intake through stimulation on CCK secretion.

*Effect of various azuki bean hydrolysates on satiety*

To examine satiating effect of azuki bean peptides, firstly CCK releasing potencies of various kinds of azuki bean hydrolysates (ABPs) were compared in STC-1 cells. The results showed that CCK secretion was similarly stimulated by all ABPs and higher than that stimulated by potato extract. However, the appetite-regulating effects in rats were different among ABPs. Azuki bean hydrolysate prepared from 'Erimoshouzu' had higher activity on suppressing food intake than the other ABPs. Treatment with a CCK receptor antagonist reversed the anorectic effect of the azuki bean hydrolysate, implying that the endogenous CCK is also responsible for the effect as well as potato extract induced satiating effect.

*Wheat gluten hydrolysate stimulates the secretion of distal gut hormone (GLP-1, PYY) and suppresses food intake*

In the experiment comparing the satiating effect of various protein hydrolysates (derived from wheat gluten, lactalbumin, soy and potato), oral preload of wheat gluten hydrolysate (WGH) suppressed food intake greater and longer than other hydrolysates.

The plasma CCK levels in WGH- and lactalbumin hydrolysate (LAH)-treated rats were similarly higher than control-treated rats 1 hr after oral preload, whereas PYY level was higher only in WGH-treated rats at 2 and 3 hrs. And plasma GLP-1 was increased 2 hrs after WGH-preload.

Because GLP-1 and PYY are produced in enteroendocrine L cells mainly located in the distal intestine, effect of WGH on L cell was examined in an L cell model cell line GLUTag. As the result, WGH effectively stimulated GLP-1 secretion in L cell model with higher potency than LAH. GLP-1 releasing potency of WGH was largely enhanced by *in vitro* digestion with pepsin/pancreatin. These results suggest that WGH is potent in activating enteroendocrine L cells to release gut satiety hormone such as GLP-1 and PYY, leading to the prolonged suppression of food intake.

This study demonstrates that ingestion of different plant proteins/peptides results in different satiating effects *in vivo*, and the effect depends on the potency to stimulate the release of gut satiety hormones. It was also found that a protein hydrolysate, WGH, has novel potency to stimulate distal enteroendocrine L cells to release GLP-1/PYY *in vivo*.

# 学位論文審査の要旨

主査	教授	原	博
副査	教授	川端	潤
副査	准教授	石塚	敏
副査	助教	比良	徹

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The thesis is composed of 99 pages, 4 tables, 22 figures, and attached with 2 related papers.

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various kinds of azuki bean hydrolysates (ABPs) were compared in STC-1 cells. The results showed that CCK secretion was similarly stimulated by all ABPs. However, the appetite-regulating effects in rats were different among ABPs. Azuki bean hydrolysate prepared from 'Erimoshouzu' (ABP-Em) had higher activity on suppressing food intake than the other ABPs. Treatment with a CCK receptor antagonist reversed the anorectic effect of ABP-Em, implying that endogenous CCK is responsible for the anorectic effect.

### **3) Wheat gluten hydrolysate stimulates the secretion of distal gut hormone (GLP-1, PYY) and suppresses food intake**

In the experiment comparing the satiating effect of various protein hydrolysates (derived from wheat gluten, lactalbumin, soy and potato), oral preload of wheat gluten hydrolysate (WGH) suppressed food intake greater and longer than other hydrolysates.

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