Chair Food Bioscience

2.7.4 Laboratory: Nutrition Chemistry

Member:	Professor	Tohru Fushiki, Dr. Agric. Sci.
	Associate Professor	Kazuo Inoue, Dr. Agric. Sci.
	Assistant Professor	Satoshi Tsuzuki, Dr. Agric. Sci.
	Assistant Professor	Shigenobu Matsumura, Dr. Agric. Sci.
	Doctor's program	3
	Master's Program	10
	Undergraduate	4
	Post-Doctoral fellow	1

A. Research Activities (2010.4-2011.3)

A-1. Main Subjects

a) Palatability of foods; Nutrition, Physiology and Brain science

It is important conception in the field of research of food science that new food resources are palatable and acceptable in human. To get this final goal, new foods are required to have a good sensitive nature, a good nutritional property, safety and many other good properties. We want to eat delicious foods. It can not be coped with a close food crisis that the development of food resources are accepted only by starving people. In this point of view, we studied what properties of food resources have high acceptability in human. Especially, we study on fat taste and the traditional "umami" taste by the analyses of interaction mechanisms on tongue of experimental animals.

b) Control of gastrointestinal epithelial turnover and the regulation by food components, and regulatory mechanism of gastrointestinal hormone secretion

The mucosal surface of the intestine comprises epithelial monolayer cells that are critical for the absorption of nutrients and defense. Aging epithelial cells must be rapidly replaced by younger cells for the maintenance of these functions. However, details of the underlying mechanism governing the rapid turnover of intestinal epithelial cells have remained unknown. We found a novel enzyme, designated membrane-type serine protease 1 (MT-SP1), and suggested that this enzyme is involved in the control of intestinal epithelial turnover under physiological conditions. Furthermore, we found that the activities of MT-SP1 and granzyme A (GrA), which is likely to induce apoptosis of abnormal intestinal epithelial cells, are regulated by food components. Our studies have revealed that some food components can regulate the turnover of the intestinal epithelium.

c) Development of special foods to increase endurance capacity.

Long-distance runners have broken many world records in recent years. Because they apparently ingested special foods to increase their endurance capacity, these exogenous substances and their effects on endurance capacity have been brought into the light. We devised an adjustable-current swimming pool for the evaluation of endurance capacity of mice. Our apparatus provides for the reliable and reproducible evaluation of the endurance capacity of mice. By using our apparatus, we studied the detecting and mechanism of the effects of dietary differences and drug pretreatment on the endurance capacity. In addition, we investigate the relation to central fatigue induced by brain TGF-beta with endurance capacity in order to clarify whether food stuff that has effects on endurance capacity also modifies the manifestation of tiredness.

d) Mechanisms of manifestation of central fatigue and TGF-beta in brain

Intracerebroventricular administration of cerebrospinal fluid (CSF) from exercise-fatigued rats elicited the decrease in spontaneous motor activity of sedentary mice, as though they were exhausted. There was no such effect in the CSF from sedentary rats. Those mice administered the CSF form fatigued-rats seemed to occur the feeling of fatigue and lose their willingness to move. We thought that the substance which involved in this phenomena was the factor that cause the feeling of fatigue. With various experiments we clarified that transforming growth factor-beta (TGF-β) was the responsible substance, because 1) the concentration of active TGF-β in CSF from fatigued-rats increased, 2) treatment of CSF from fatigued-rats with anti-TGF-β antibody eliminated the effect of decreasing spontaneous motor activity of mice, 3) elevating exercise load on rats increased both the concentration of active TGF-β in CSF and the inhibitory effect on spontaneous motor activity on mice, and 4) purified TGF-β dose-dependently depressed the spontaneous motor activity of mice. These results strongly suggested that active TGF-β in the brain elicited the manifestation of central fatigue and depression in willingness to move.
In addition, we showed the administration of TGF-β into the brain could augment the ratio of utilization of fatty acid in whole body and the preference for sweet taste. These indicated that active TGF-β in the brain not only caused feeling of fatigue, but affected to peripheral tissues (via autonomic nervous system) and involved in the mechanisms which changed metabolic state to the one during/after exercise.

e) Recognition mechanism of dietary fat by taste bud cells

Fatty food are palatable and we are often attracted by such a high caloric or high fat foods. Recent studies suggested that the chemical perception of fatty acid is involved in the acquisition of a strong preference for fat. Circumstantial evidence has begun to accumulate that may explain the mechanism underlying the reception of fatty acid. We are now investigating the recognition mechanism of dietary fat by using behavioral and physiological experiments.

A-2.Publications and presentations

a) Publications

Books

- Fushiki T: How shall we nurse taste in childhood, Mebae-sha, 2010

- Fushiki T, Inoue K: Changes of energy metabolism and brain TGF-beta during exercise. Nutrition and Sports medicine, Kenpakusha, 2010

- Manabe Y, Matsumura S, and Fushiki T., Preference for High-Fat Food in Animals. In: Montmayeur JP, le Coutre J, editors. Fat Detection: Taste, Texture, and Post Ingestive Effects. Boca Raton (FL): CRC Press; 2010. Chapter 10. 2010.

Original Papers(including book-reviews)

- Intragastric administration of allyl isothiocyanate increases carbohydrate oxidation via TRPV1 but not TRPA1 in mice. Mori N, Kawabata F, Matsumura S, Hosokawa H, Kobayashi S, Inoue K, Fushiki T.
Am J Physiol Regul Integr Comp Physiol. 2011 Mar 23.

- Effect of an intraduodenal injection of fat on the activities of the adrenal efferent sympathetic nerve and the gastric efferent parasympathetic nerve in urethane-anesthetized rats. Matsumura S, Eguchi A, Kitabayashi N, Tanida M, Shen J, Horii Y, Nagai K, Tsuzuki S, Inoue K, Fushiki T. Neurosci Res. 2010 Jul;67(3):236-44

- Mochida S, Tsuzuki S, Inouye K, Fushiki T: A recombinant catalytic domain of matriptase induces detachment and apoptosis of small-intestinal epithelial IEC-6 cells cultured on laminin-coated surface. J Biochem 148(6):721-32, 2010

- Inouye K, Tsuzuki S, Yasumoto M, Kojima K, Mochida S, Fushiki T: Identification of the matriptase second CUB domain as the secondary site for interaction with hepatocyte growth factor activator inhibitor type-1. J Biol Chem 285(43):33394-403, 2010

- Tsuzuki S, Murai N, Miyake Y, Inouye K, Fushiki T: The structural requirements of matriptase in its ectodomain release in polarized epithelial cells. Biosci Biotechnol Biochem 74(6):1295-7, 2010

- Yoshikawa Y, Hirayasu H, Tsuzuki S, Fushiki T: Granzyme A and thrombin differentially promote the release of interleukin-8 from alveolar epithelial A549 cells. Cytotechnology62(4):325-32, 2010

- Miyake Y, Tsuzuki S, Fushiki T, Inouye K: Matriptase does not require hepatocyte growth factor activator inhibitor type-1 for activation in an epithelial cell expression model. Biosci Biotechnol Biochem 74(4):848-50, 2010

- Inouye K, Yasumoto M, Tsuzuki S, Mochida S, Fushiki T: The optimal activity of a pseudozymogen form of recombinant matriptase under the mildly acidic pH and low ionic strength conditions. J Biochem 147(4):485-92, 2010

- Tsuzuki S, Miyake Y, Inouye K, Fushiki T: The occurrence of matriptase C-terminal fragments on the apical and basolateral sides of Madin-Darby canine kidney epithelial cells. Biosci Biotechnol Biochem 73(11):2538-40, 2010

- Miyake Y, Tsuzuki S, Mochida S, Fushiki T, Inouye K: The role of asparagine-linked glycosylation site on the catalytic domain of matriptase in its zymogen activation. Biochim Biophys Acta. 2010 Jan;1804(1):156-65, 2010

- Kitaoka R, Fujikawa T, Miyaki T, Matsumura S, Fushiki T, and Inoue K., Increased noradrenergic activity in the ventromedial hypothalamus during treadmill running in rats. J Nutr Sci Vitaminol (Tokyo) 56: 185-190, 2010.

- Fujikawa T, Fujita R, Iwaki Y, Matsumura S, Fushiki T, and Inoue K., Inhibition of fatty acid oxidation activates transforming growth factor-beta in cerebrospinal fluid and decreases spontaneous motor activity. Physiol Behav 101: 370-375, 2010.

Reviews

- Fushiki T. Relax effect by soft scent of jasmine. Aromatopia, 112,33-36,2010

- Inoue K. TGF-βin the brain, as a fatigue subsutance. Taiikunokagaku, 60; 819-823, 2010

b) Conference and seminar papers presented

- ECRO2010, 1. Presentation
- 20th Annual meeting of Health and medical science (1 paper)
- Annual meeting of Japan Society for Bioscience, Biotechnology, and Agrochemistry (8 papers)
- Annual meeting of Japanese Society of Nutrition and Food Science (6 papers)
- Annual meeting of the Japanese Association for the Study of Taste and Smell (4 papers)
- Annual meeting of Japan Society for Spice Research (2 papers)

- The 33rd Annual Meeting of Molecular Biology Society of Japan, The 83rd Annual Meeting of the Japanese Biochemistry Society (1 paper)

A-3.Off-campus activities 2

Research grants

1. Grants-in-aid for Scientific Research(KAKENHI)

- Grant-in-Aid for Scientific Research(B) : Fushiki Tohru : Animal behavioral study on a candidate protein for fat receptor.

- Scientific Research (B) : Inoue, Kazuo : Establishment of the evaluation system for central fatigue and the development of preparative basis for food which aims the control of fatigue

- Scientific Grant © : Tsuzuki, Satoshi : Elucidation of the role for granzyme A, a binding molecule of monitor peptide, in the peptide-mediated CCK release

- Grant-in-Aid for Young Scientists (B) : Shigenobu, Matsumura : Mechanism of induction of addictive behavior for fatty foods

2.Other Research Grants

- Promotion of Basic Research Activities for : Fushiki Tohru : Practical studies on dietary lipids of low calorie and high preference.

- Grant from Ryoshoku kenkyu-kai : Fushiki, Tohru : Establishment of profile palate element method for evaluation of food palatability for elderly people and its application to dairy products

- Grant-in-Aid from the Society for Research on Umami Taste : Shigenobu, Matsumura : Construction of model system assessing food palatability

B.Educational Activities(2010.4-2011.3)

B-1.On-campus teaching

a) Courses given

- Undergraduate level : Nutrition Chemistry (Fushiki), Taste and Preference (Fushiki), Laboratory course in food and nutrition chemistry (Inoue, Tsuzuki, Matsumura), Introduction to foreign literature in food science and biotechnology II (Inoue, Hashimoto), Basic course in information processing (Inoue, Hashimoto)

- Graduate level : Nutrition Chemistry (Advanced course) (Fushiki, Inoue), Laboratory Course in Nutrition Chemistry (Fushiki, Inoue)

B-2.Off-campus teaching etc.

Part-time lecturer

- Fushiki T: The University of Shiga Prefecture , School of Human Cultures: Food and Nutrition Chemistry, University of Marketing and Distribution Sciences, Faculty of Service Industries: Science of taste

Open lectures, etc.

- Fushiki T: Open Sympojium Fronteir of Food function study, Japan University, Lecturer

- Fushiki T: Health and Medical Care Forum, Asahi News paper Company, Lecturer

- Fushiki T: Senri lifescience forum, Senri Lifescience fundation, Lecturer

C.Other Remarks

- Fushiki, Tohru : Japan society for the promotion of science, Committee of grant-in-aid for scientific research, member, Uragami promotion foundation for food and culture, director, Academy of Japanese cuisine, director, Foundation of Sugiyama Reserch Institute for Industrial Chemistry, director, Japanese association of enzyme application, councilor, Fuji Protein committee for research promotion, councilor, Kyoto central wholesale market, Committee for fullfillment strategy of foothold of food, member