教員研究課題一覧

Research Topics Catalogue

2017

香川大学農学部

Faculty of Agriculture
Kagawa University

教員の専門領域と研究分野
Research Area and Specialization

領域 Research Area	氏名 Name	研究分野 Research Specialization	氏名 Name	研究分野 Research Specialization
食料生産学 Bioresource Production Science	東江　栄 AGARIE, Sakae	資源植物機能学 Function of Plant Resources	松本　由樹 MATSUMOTO, Yoshiki	畜産学（動物生体機構学） Animal Science
	豊田　正範 TOYOTA, Masanori	作物生態生理学 Crop Ecophysiology	武藤　幸雄 MUTO, Yukio	農業経済学 Agricultural Economics
	亀山　宏 KAMEYAMA, Hiroshi	農業経済学 Agricultural Economics	諸隈　正裕 MOROKUMA, Masahiro	作物栽培学 Crop Husbandry
	松村　伸二 MATSUMURA, Shinji	農業気象学 Agricultural Meteorology	川﨑　淨教 KAWASAKI, Kiyonori	動物栄養学 Animal Nutrition
園芸科学 Horticultural Science	奥田　延幸 OKUDA, Nobuyuki	蔬菜園芸学 Vegetable Crop Science	望岡　亮介 MOCHIOKA, Ryosuke	果樹園芸学 Pomology
	片岡　郁雄 KATAOKA, Ikuo	果樹資源学 Conservation and breeding for kiwifruit and related species	柳　智博 YANAGI, Tomohiro	施設生産学 Greenhouse　production
	高村　武二郎 TAKAMURA, Takejiro	園芸資源開発学 Horticultural breeding	小杉　祐介 KOSUGI, Yusuke	園芸利用生理工学 Postharvest Horticulture
	深井　誠一 FUKAI, Seiichi	花き園芸学 Floriculture	鳴海　貴子 NARUMI, Takako	花き園芸学 Floriculture
	別府　賢治 BEPPU, Kenji	果樹園芸学 Pomology		
環境生態機能学 Environmental & Ecological Science	一見　和彦 ICHIMI, Kazuhiko	浅海生産環境学 Coastal Marine Science	小林　剛 KOBAYASHI, Tsuyoshi	植物生態学 Plant Ecology
	伊藤　文紀 ITO, Fuminori	昆虫生態学 Insect Ecology	安井　行雄 YASUI, Yukio	進化生態学 Evolutionary Ecology
	多田　邦尚 TADA, Kuninao	化学生物海洋学 Chemical and Biological Oceanography	山口　一岩 YAMAGUCHI, Hitomi	沿岸物質循環論 Coastal Biogeochemistry
	山田　佳裕 YAMADA, Yoshihiro	水環境科学 Water Environmental Science	豊田　鮎 TOYOTA, Ayu	土壌生態学 Soil Ecology
生物分子化学 Biological Molecular Chemistry	片山　健至 KATAYAMA, Takeshi	森林バイオマス化学 Forest Biomass Chemistry	鈴木　利貞 SUZUKI, Toshisada	バイオマス化学 Biomass Chemistry
	加藤　尚 KATO, Hisashi	植物分子化学 Plant Biochemistry	古本　敏夫 FURUMOTO, Toshio	植物機能化学 Functional Phytochemistry
	川浪　康弘 KAWANAMI, Yasuhiro	有機合成化学 Synthetic Organic Chemistry	柳田 亮 YANAGITA, Ryo C.	ケミカルバイオロジー Chemical Biology
	佐藤　正資 SATO, Masashi	生物活性天然物化学 Bioactive Natural Products Chemistry	KONG, Lingbing	Rare sugar organic chemistry
	深田　和宏 FUKADA, Kazuhiro	生物物理化学・コロイド化学 Biophysical Chemistry & Colloid Science		
植物科学 Plant Science	秋光　和也 AKIMITSU, Kazuya	植物病理学 Plant Pathology	五味　剣二 GOMI, Kenji	植物病理学 Plant Pathology
	京　正晴 KYO, Masaharu	植物細胞発生生物学 Plant Cellular and Developmental Biology	杉田　左江子 KONISHI-SUGITA Saeko	植物分子育種学 Plant Science
	野村　美加 NOMURA, Mika	植物栄養学 Molecular Plant Nutrition	池田　滋 IKEDA, Shigeru	体細胞遺伝学 Somatic Cell Genetics
	藤田　政之 FUJITA, Masayuki	植物ストレス応答学 Plant Stress Responses	望月　進 MOCHIZUKI, Susumu	希少糖遺伝子工学 Rare sugar molecular biology
	市村　和也 ICHIMURA, Kazuya	植物ゲノム機能解析学 Plant Functional Genomics and Plant immunity		
生命機能科学 Life Science & Biotechnology	麻田　恭彦 ASADA, Yasuhiko	微生物利用学 Applied Microbiology	田中　直孝 TANAKA, Naotaka	応用微生物学 Applied Microbiology
	木村　義雄 KIMURA, Yoshio	微生物生理学 Microbial Physiology	渡邉　彰 WATANABE, Akira	微生物生化学 Microbial Biochemistry
	櫻庭　春彦 SAKURABA, Haruhiko	酵素工学 Enzyme Engineering	加藤　志郎 KATO, Shiro	希少糖酵素工学 Rare Sugar Enzymology
	田渕　光昭 TABUCHI, Mitsuaki	応用分子細胞生物学 Applied Molecular Cell Biology	杉山　康憲 SUGIYAMA, Yasunori	動物細胞生物学 Animal cell biology
	末吉　紀行 SUEYOSHI, Noriyuki	分子細胞生物学 Molecular and Cellular Biology		
食品科学 Food Science	小川　雅廣 OGAWA, Masahiro	食品タンパク質化学 Food Protein Functionalities	高田　悟郎 TAKATA, Goro	応用酵素化学 Applied Microbiology & Enzyme Chemistry
	川村　理 KAWAMURA, Osamu	食品衛生学 Food Hygiene	森本　兼司 MORIMOTO, Kenji	酵素利用学 Applied Enzymology
	合谷　祥一 GOHTANI, Shoichi	食品物理学 Food Physics	吉原　明秀 YOSHIHARA, Akihide	酵素利用学 Applied enzymology
	田村　啓敏 TAMURA, Hirotoshi	食品機能分子化学 Molecular Nutrition and Chemistry on Food materials	米倉　リナ YONEKURA, Lina	食品機能化学 Food chemistry and functionality
	松尾　達博 MATSUO Tatsuhiro	食品栄養学 Food Nutrition	LUTES, Peter Gerald	（応用言語学） （Applied Linguistics）
	吉井　英文 YOSHII, Hidefumi	食品工学 Food Engineering		

Area of specialization Food Production
Research Specialization Function of Plant Resources
Faculty name AGARIE, Sakae

Key words: CAM, halophylism, ice plant, salt tolerance, edible wild plants

Research topics

1. Stress-inducible transition of photosynthesis

The photosynthetic mode of higher plants are classified into three modes: C3, C4 and CAM. The common ice plant *Mesembryanthemum crystallinum* shifts its photosynthetic mode from C3 to CAM under abiotic stress conditions such as high light, drought, and salinity. We study the molecular mechanisms regulating the salt-inducible and diel expression of genes which encode the key enzymes of CAM.


The common ice plant

2. Halophilism in halophyte

Some halophytes promote their growth under high salinity condition where most crop would die. To understand the mechanism of the trait (halophylism) we elucidate the effects of NaCl on the factors responsible for the cell division and cell elongation. We found that the incorporation of potassium into cytosols and ATP synthesis in mitochondria were promoted by NaCl, suggesting that these factors might be related to the halophilism.


Bladder cells

3. Phytoremediation

The common ice plant is capable to accumulate NaCl and heavy metals (e.g. Cu and Cd) in their tissues at higher levels. We have trying to establish methods to remove the contaminants efficiently from the salinized and heavy metals contaminated soils. *Cyperus alternifolius*, known as the "umbrella plant" is a marginal pond plants native to Madagascar has high biomass productivity and nutrient absorption. We conduct a field experiment to purify the eutrophic pond in Kagawa using this species growing in floating raft, and evaluate the umbrella plant as a biofuel material.


Umbrella plant

4. Use of edible wild plants as new functional vegetable

Wild plants have useful properties such as biotic and abiotic stress tolerances that crops have lost during domestication. The compounds synthesized in the wild plant in response to the abiotic stresses are sometimes highly functional for human health. We evaluate the characteristics as a new functional crop such as productivity, functionality, and availability for production on a commercial basis.


Ice plant new cultiver KA-I243

Representative research achievements

1. Ku et al., 1999. High-level expression of maize phosphoenolpyruvate carboxylase in transgenic rice plants. Nature Biotech., 17, 76 – 80, 1999.
2. Agarie et al., 2007. Salt tolerance, salt accumulation, and ionic homeostasis in an epidermal bladder-cell less mutant of the common ice plant *Mesembryanthemum crystallinum*. J. Exp. Bot., 58, 1957-1967, 2007.
3. Cushman et al., 2008. Isolation and characterization of mutants of common ice plant deficient in Crassulacean acid metabolism. Plant Physiol., 147, 228-238.

登録商標:①クリスタルリーフ(登録番号5063811), ②バラフ(登録番号5058041), ③Barafu(登録番号5058042).
特許等:①アイスプラントの生育を促進しNa/K含量比を増加させる栽培法(特願2008-104632);②Method of constructing transgenic ice plant. Australia 2005330877, (2011)., United States Patent. US 8, 101, 824., (2012); ③アイスプラント新品種KA-I243, 品種登録出願番号第26999号(2012).

Research Area: Food Production
Research Specialization: Crop Ecophysiology
Name: TOYOTA, Masanori

Keywords: Crop ecophysiology, Field crop, High yielding, Light quality
Water-saving culture, Yield determination.

Recent Research

1. Controlling shade avoidance response as an avenue to increase potential crop yield

A lowered ratio of red and far-red irradiance (R:FR) is a warning signal for future competition, triggering plant morphogenic responses for shade avoidance, seen as increased apical dominance and reduced axillary bud growth. The growth and survival of tillers in wheat controlled by R:FR determines the final number of spike which is a major component of wheat yield. This study tests the hypothesis whether the reducing shade avoidance response increase the number of tiller in wheat or branch in soybean, and therefore increase yield potential.

2. Rice cultivation with drip irrigation for water-saving and greenhouse gas mitigation

Drip irrigation system, which has been developed for water-saving in arid land agriculture, is now applied to large-scale upland rice cultivation in some countries. In this study, drip rice cultivation in upland field is performed to estimate how much water could be saved compared to paddy, and to evaluate the emission reduction of methane: because paddy rice is one of the major source of methane emission in agriculture.

3. Ecophysiological approaches to maximize potential yield of Japanese soybean

Japanese soybean yield (1.6 t/ha) is only half of that in advanced cultivation country. This study aimed to optimize light interception and radiation use efficiency in soybean canopy using different cultivars or environment to improve cultivar and cultivation technologies, and to maximize potential yield of Japanese soybean.

Publications

Laaorthip, M. and Toyota, M. (2017) A high seed yield and associated attributes of dry matter production achieved by recent Japanese soybean cultivars, Plant Production Science, 20(2), 193-204.

Toyota, M., *et al*. (2017) Changes in radiation interception and R:FR over time and with canopy depth of two soybean cultivars with different branching characteristics. Plant Production Science, 20(2), 205-214.

Toyota, M., *et al*. (2014) Tillering responses to high Red: Far-red ratio of four Japanese wheat cultivars. Plant Production Science 17, 124-130.

Toyota, M., et al. (2010) Effects of reduction in plant height induced by chlormequat on radiation interception and radiation-use efficiency in wheat in southwest Japan. Plant Production Science 13, 67-73.

Toyota, M., *et al*. (2001) Initiation and development of spikelets and florets in wheat as influenced by shading and nitrogen supply at the spikelet phase. Plant Production Science 4, 283-290.

Research Area: Bioresource Production Science
Research Specialization: Agricultural Economics
Name: KAMEYAMA, Hiroshi

Keywords : regional development, food demand and supply, communication, facilitation

Recent Research

1. Communication for Production Area renovation

For the production promotion of Kagawa, agriculture features multi-items small volume production. In promoting the production of new brand agricultural products, there are issues such as changing the allocation of labor by type and cropping type. We developed a land use model and examined issues of agreement formation between shipping organization and producers.

2. Rural management and facilitation

The sustainment of the community is a serious in the hilly area. Activities such as the creation of regional special products and initiatives for events are being made. We are conducting an intention survey on the evaluation of visitors of the event. We examined the human resources training in organizations in agriculture and rural areas, especially the facilitation type leadership to promote collaboration.

3. Regional integration and price transmission

For the economic development of the East Africa region, application of economic evaluation of easing of food import restrictions by the EU, computer general equilibrium model analysis. In Turkey, structural transformation due to EU accession for the agriculture by food supply and demand model.

Interdependence relationship between grain market and crude oil market in international market was analyzed.

4. Impact Evaluation to development issues

Based on the experiences in evaluating multi-functionality in agriculture project, we evaluated the impact (the difference between outcome of treatment group and outcome of control group) with agricultural village survey in Kagawa. We will adapt to access various policy interventions.

Publications

Click hear to know more detail information.

・**Kameyama,H**.,Mogotlane,M.(2017) Visitor's Evaluation of the event at the friendship center in the hilly area, Association of Rural Planning, March, U. of Tokyo. (in Japanese)

・Yan, S., **Kameyama**, **H**., Isoda, H., Qian, J., Ito, S.(2016) Effects of International Grain Prices on Volatility of Domestic Grain Prices in 24 Developing Countries, Journal of Faculty of Agriculture, Kyushu University, **61**(1), 225 – 232.

・**Kameyama**, **H**.(2013) Communication for production renovation in Multi and small production region: the profitability of Obarabeni-wase, special Issues, Journal of Rural Economics,100-106. (in Japanese)

・**Kameyama**, **H**., Ngamsomsuke, K. Ito, S.(2013) Regional comparison for cassava profitability by risk analysis, The Association for Regional Agricultural and Forestry Economics, Oral presentation, Okayama University. October. (in Japanese)

・Kelali, A. T., **Kameyama**, **H**., **Ito**, H., **Itohara**,Y.(2008) Impacts of free trade area (FTA) within Eastern and Southern countries and unilateral tariff elimination by other regions, Journal of Food, Agriculture & Environment, **6**(2) ,132-137.

・**Kameyama**, **H**.,**Cakmak**, **H**. **E**., **Lu**, **Y**. (2006) The economic impact of EU membership on agriculture in Turkey, Faculty of Agriculture, Technical Bulletin, Kagawa University **59**, 27-43. (in Japanese)

Research Area: Food Production
Research Specialization: Agricultural Meteorology
Name: MATSUMURA, Shinji

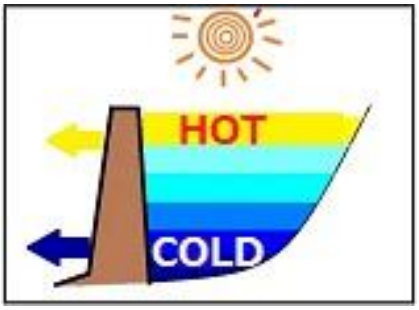
Keywords : **natural disaster, climatic resources, extreme weather**

Recent Research

1. Mechanism analysis of agricultural damage causing by natural disasters

Recently large scale disasters caused by unusual weather have become more frequent in Japan and agricultural damage tend to increase too. According to the IPCC's current findings,it is expected that extreme weather,such as heat wave and cool summer, is more likely to appear in future. Mechanism of global warming have been clarified a lot scientifically, but then mitigation method of agricultural damage was not enough studied. In my laboratory,the methods that mitigate high stress of plants and animals at severe event by physical way are studied.

2.Development of unused natural energy resourses and effective use for agriculture



Agricultural climate resources is the idea that climate is assessed as the resources. It follows that temperature ,solar radiation and precipitation are natural energy resources. Irrigation reservoir with a wide distribution in west Japan has cold energy resources at the deep bottom. In my laboratory, the effective utilization methods of cold energy resources for agriculture are investigated.

Publications

Zhong,G., Wang,X., Tani,H., Guo,M., Chittenden,A.,Yin,M.,Sun,Z. and Matsumura,S. : A Modified Aerosol Free Vegetation Index Algorithm for Aerosol Optical Depth Retrieval Using GOSAT TANSO-CAI Data,Remote Sensing, 8, No.12, 998-1019, 2016.

Matsumura,S., Yoshizawa,H.,Matsumura,O., Komoti,S., Hyayashi,Y., Okada,M.:Extreme hot summer and agricultural damages in 2010(in Japanese), J. Natural Disaster, 30, No.2, 169-192, 2011.

Matsumura, S., Sugaya, H. and Kimura, M.: Characteristics of Water Shortage and Precipitation Patterns in Kagawa Prefecture, J. Agric. Meteorol., 60, 897-900, 2005.

Shinji,M. and Morokuma,M.:Cold water irrigation during grain filling and appearance quality of paddy rice producted in 2014(in Japanese), Agricultural Meteorology of Chugoku and Shikoku, 26, 32-33, 2014.

Research Area: Food Production
Research Specialization: Animal Science
Name: MATSUMOTO, Yoshiki

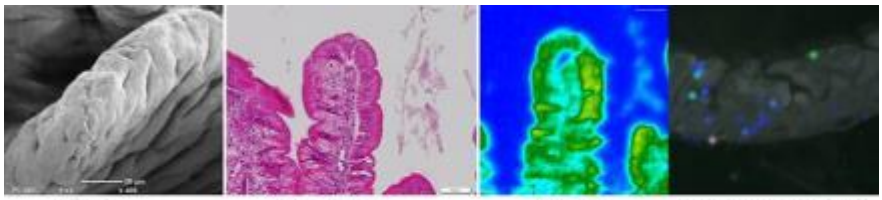
Keywords : Neuroscience, Intestinal Villus, Microbiota, Trapping Device, Red mite, Feeding environment and Poultry health.

Research Interests

Our primary interest is the development of functional animal production sciences, widely anatomy and physiology, statistically detecting the target molecule expression and localization, quantitative absorbed amino acid using new imaging methods on an intestine villus tips and contributing for future industrial sustainability. Particularly, this is very topical and important for safety animal products, poultry health that has affected by intestinal microbiota, and in understanding and developing theoretical principles of feeding environment.

1. Gut mucosal functions and health in poultry

The poultry industry needs more stable production which will require an improved environment for layers and better health controls. One major health and environmental concern is caused by feeding related microbiota on intestinal villus. Fourier Transform Infrared imaging (FT-IRI) is possible to analyze collagen maturity, crystallization and calcification, and to estimate organic compound by analyzing atomic bonds (-C=O -O-H $-PO_4^{3-}$ etc.) in tissues. FT-IRI and MALDI-TOF MSI are establishing new methods to evaluate certain nutrient absorption in terms of morphology and physiology combined with SEM and light microscope.



2.Epidemiological research and developing ectoparasite trap devices

Dermanyssus gallinae (De Geer, 1778), known as the “red mite,” is a hematophagia ectoparasite, commonly found in laying hens and is one of the most important epidemiological and economic problems. We have developed an electrostatic charged device (*i* -Trap®, Kondo-Electric Co., Ltd.) which can attract and capture red mites without the use chemicals or insecticides. This device has an electrical charge from static electricity that is created by the polyurethane composition of the material. This allows for quantification of the red mite infestation population from which the contamination level forred mites can be determined.

Publications

・Egg collagen content is increased by a diet supplemented with wood charcoal powder containing wood vinegar liquid, ***British Poultry Science***, 57, 601-611, 2016, Yamauchi K, Matsumoto Y and Yamauchi KE.

・Increased collagen accumulation in eggshell membrane after feeding with dietary wood charcoal powder and vinegar, ***Connective Tissue Research***, 54(6), 416-25, 2013. Yamauchi K, Manabe N, Matsumoto Y, Yamauchi KE.

・Red mite population: Increase has a direct correlation to a decrease in egg production, ***17th AAAP*** 1070-1074, (2016). Imade Y., Kondo T., KayaharaY.,Yamauchi K., Lutes P., Matsumoto Y.

・New parameters and evaluation: Collagen-related molecules in chicken intestine, ***17th AAAP ANIMAL SCIENCE CONGRESS*** 156-160, (2016). Takagi R, Yamauchi KE Matsumoto Y.

・Pest-accumulating device and pest-accumulating method, Patent Number: JP 5690986 , US9510583, TH1501000949, CN201380043196. Matsumoto Y, .Kondo T, Yamauchi K and Yamauchi KE.

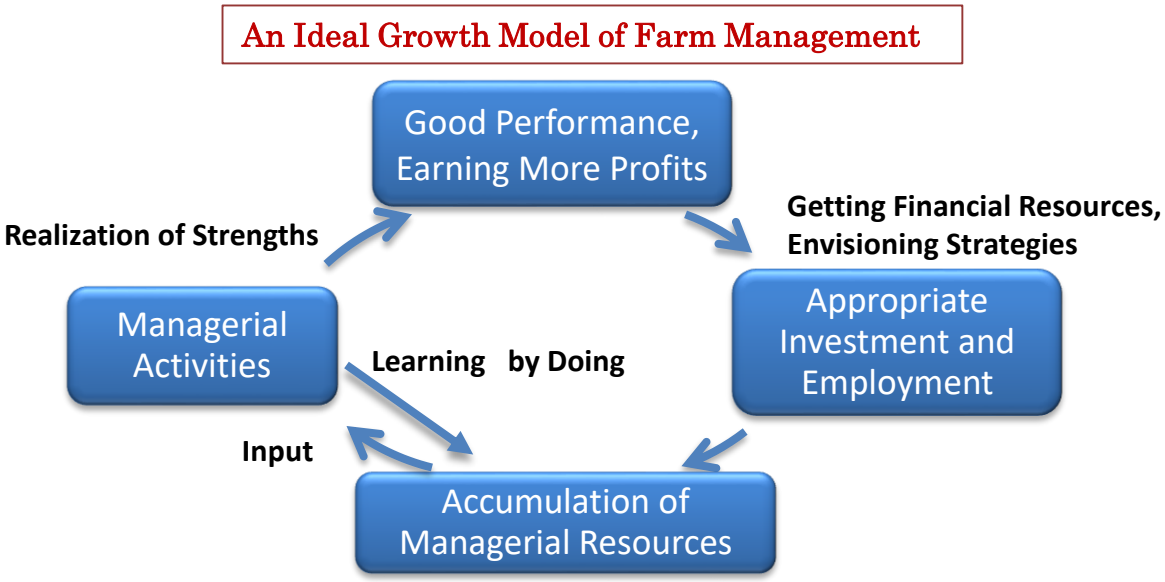
Research Area: Bioresource Production Science Course
Research Specialization: Agricultural Economics
Name: MUTO, Yukio

Keywords : managerial resources, managerial strengths, constraints on farm management growth

Research issue: **Economic Analysis on the Growth Processes of Farm Managements in Japan**

In agriculture, farmers can obtain managerial resources by appropriate investment and employment using financial resources, and by acquiring skills with "learning by doing" on their farms. We can envision an ideal growth model of farm managements, where, accumulating and using managerial resources, farmers realize managerial strengths to earn more profits (see the figure below). In Japan, however, most farmers cannot follow such a model, thus failing to grasp growth opportunities.

In our laboratory, using economic theory and econometric tools, we analyze how socio-economic constraints lead Japanese farmers to give up following the ideal growth model, and what should be done to alleviate those constraints.



Publications

・Yukio Muto, "Fault-Responsibility-Dilemmas and Distortions in Pest Control Advising". *The Japanese Journal of Rural Economics* **3**, 1-14 (2001).

・Yukio Muto, "The Use of Non-linear Tariffs for Irrigation Water in Agricultural Drainage Control". *The Journal of Rural Economics* 81(3), 179-192 (2009), in Japanese.

・Yukio Muto, "Consideration of the Tendencies in Employment Management and Human Resource Development in Farm Organizations". *The Journal of Rural Problems* 53(2), 99-107 (2017), in Japanese.

Research Area: Food Production
Research Specialization: Crop Husbandry
Name: MOROKUMA, Masahiro

Keywords: **crop, rice, unused resources, sustainable agriculture, organic cultivation.**

Recent Research

1. Studies on Organic Cultivation of Crops

Organic cultivation without chemical fertilizers and agrochemicals are sustainable agriculture which reduce stress to environment depending on crop production and use resources effectively. And it will be benefit for sell because of additional values.

In our laboratory, we started organic cultivation of rice at 2005 in paddy field of University Farm. We study the effect of organic materials on weeds and rice yield. We simultaneously study organic cultivation of upland crops for crop rotation in paddy field.

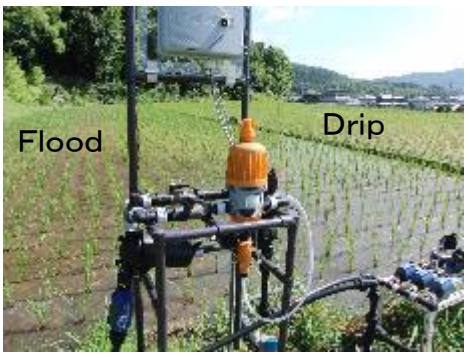
Table Effect of organic materials on dry weight of monochoria during heading time(2016).

Materials	Dry weight(g/m^2)
Rice Bran 100	58.6
Rapeseed Meal 100	5.6
Camellia Meal 100	83.3
Camellia Meal 500	5.3
control	102.3

2. Studies on water saving cultivation of paddy rice

It will be important for the future concerned water shortage to accumulate the information about water saving cultivation of rice.

In our laboratory, we introduce drip irrigation system to paddy field of University Farm, and study the effect of this system on water saving extent and rice yield.



3. Studies on water saving cultivation of paddy rice

There are many unused resources, for example, food waste, waste from vegetable shipping adjustment, etc., We study to use them to crop production as organic materials. Now, we investigate to use sake cake and food waste to rice or vegetable production.

Publications

Combined application of oil cake and rice bran reduced the number of weeds and increased the yield of paddy rice in a paddy field incorporated with white clover, 9th Asian Crop Sci. Association Conference, 287, 2017, Sugimoto, H., Araki T., **Morokuma, M.** and Hossain S.T.

The use of desalinated-dried jellyfish and rice bran for controlling weeds and rice yield, Journal of organic systems, 8, 28-37, 2013, Hossain, S.T., Sugimoto, H., Asagi, N., Araki, T., Ueno, H., **Morokuma, M.** and Kato H.

Role of dried jellyfish as an innovative means of organic rice production, Proceeding of the 6th international weed science congress, Hangzhou, China, 92, 2012, Sugimoto, H., Hossain, S.T., Asagi, N., Ueno, H., Araki, T., **Morokuma, M.** and Kato, H.

Research Area: Food Production
Research Specialization: Animal Nutrition
Name: KAWASAKI, Kiyonori

Keywords: black soldier fly, sustainable agriculture, swine, rabbit

Recent Research

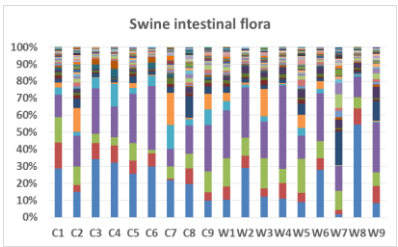
1. Development of Sustainable Food production System Using the Functions of Insects

At a Global level, the use of insect as waste bioconverters for the production of innovative products is a very hot topic. The larvae stage of the Black soldier fly, *Hermetia illucens* (BSF) can convert large volumes of low-grade organic substrates into valuable biomass.

We evaluate the products (FEED and FERTILIZER) obtained through the bioconversion of organic waste by BSF larvae.

2. Effect of Feeding Unused Resources on Livestock

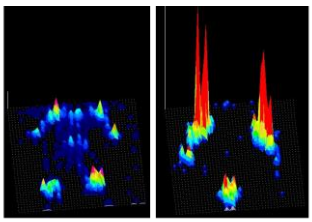
We investigate what kind of changes will occur in livestock by using food byproducts and regional resources (such as wine filtration residues and olive lees) that have not been used yet by intestinal flora analysis or metabolome analysis



3. Development and Dissemination of Cuniculture

Rabbit production (CUNICULTURE) could be an important source of food for Japanese people, because high-protein meat can be produced from rabbits mostly fed on grass in only 70 days. Moreover, rabbit meat could become an important alternative source of protein for people with food intolerance to beef, pork and/or chicken.

In our laboratory we study differences between Japanese and overseas in the cuniculture, rabbit feed, nutrition of rabbit meat, and illness of rabbits.



The burden on the foot is different between light weight (left figure) and heavy weight (right figure).

Publications

・The Japanese white, an Akita-improved rabbit variety: Current status and problems of its farming in Japan, and possible strategies for sustenance. The 17th Asian-Australasian Association of Animal Production Societies Animal Science Congress Proceedings, 1549-1554. 2016. **Kawasaki, K.**, Hori, A., and Yano, K.

・Dietary Mannitol Increased the Absorption of Calcium and Magnesium in Rats. Journal of Animal Physiology and Animal Nutrition 100, 715-722. 2016. Xiao, J., Sakaguchi, E., Min, X., and **Kawasaki, K.**

・Transfer of blood urea nitrogen to cecal microbial nitrogen is increased by fructo-oligosaccharide feeding in guinea pigs. Animal Science Journal, 86(1), 77-82, 2015. **Kawasaki, K.**, Xiao, M., Xiao, L., Hasegawa, E., and Sakaguchi, E.

・Transfer of blood urea nitrogen to cecal microbes and nitrogen retention in mature rabbits are increased by dietary fructooligosaccharides. Animal Science Journal 85(6), 671-677, 2014.Xiao, M., Jin, X., **Kawasaki, K.**, Xiao, L., and Sakaguchi, E.

Research Area: Horticultural Science
Research Specialization: Vegetable Crop Science
Name: OKUDA, Nobuyuki

Keywords: vegetable crops, growth and development regulation, raising of superior strain

Recent Research

1. Morphogenetic control of the lettuce under the high temperature condition

On the high temperature condition, a lettuce forms a flower buds and elongates a stem. Therefore, the morphological product value of the lettuce decrease remarkably by global warming. We study the morphogenetic control technology of the lettuce under the high temperature condition to resist global warming.

2. Ecological characteristic of a asparagus

In West Japan, a asparagus is harvested from spring to the autumn, we cannot harvest a asparagus spears from October to February . Furthermore one major problem of the asparagus cultivation is the asparagus decline. In our laboratory, it is studied the reduction of asparagus growth in the low temperature period and measures for the asparagus decline.

3. Production of high functional vegetables

The quality of vegetables greatly varies according to an environmental condition. We study the cultivation condition to produce high functional vegetables which attract attention.

4. Raising of superior strain of *Brassica* vegetable

Generally, the flower vegetable has high nutritive value, and these consumptions increase. We study raising of superior strain of Brassica flower vegetables.

Publications

Okuda, N. et al. (2017) Effects of end of day lighting after night chilling treatment on the growth and development of lettuce. Environmental Control in Biology, **55**, 7-11.

Okuda, N. et al. (2015) Effect of glutathione blended fertilizer on the growth and development of garlic. Hort. Res.(Japan) 14 (SUPPL.2).483.

Okuda, N. et al. (2014) Effect of end-of-day light irradiation using LED light sources on the growth of lettuce under a high temperature. Environmental Control in Biology, **52**, 73-77.

Okuda, N. et al. (2014) Effects of end-of-day irradiation after short-day and night-cooling treatment on the growth and development of lettuce. The International Conference on Plant Factory 2014, abstract p.30. Kyoto, Japan

Okuda, N. et al. (2012) Effects of bamboo charcoal to reduce growth inhibition caused asparagus, Hort. Res.(Japan) **11**, (Suppl.2) , 463.

Okuda, N. et al. (2011) Effects of glutathione application on the flower bud formation of choy sum, Hort. Res.(Japan) **10**(Suppl.2) , 478.

Okuda, N. et al. (2009) Studies on flower bud and seed formation of Chinese kale: a Brassica adjusted in the tropics, Research for tropical Agriculture **2**, 52-55.

Research Area: Horticultural Science
Research Specialization: Conservation and breeding for kiwifruit and related species
Name: KATAOKA, Ikuo

Key word：kiwifruit, actinidia, native species, conservation, breeding

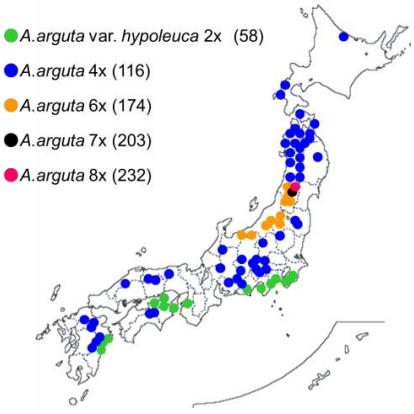
Recent Research

1. Field survey and conservation of wild *Actinidia* species related to kiwifruit in Japan

A.arguta (Sarunashi), *A.polygama* (Matatabi), *A.kolomikta* (Miyamamatatabi) and *A.rufa* (Shimasarunashi) are Actinidia species related to kiwifruit and naturally occur in Japan. Focusing on the valuable traits of these native resources, we have surveyed the indigenous plants all over the country and conserved the resources.

As the results, *in A. arguta*, there are very wide range of ploidy variation from diploid to octaploid. The ascorbic acid content and protease activity in the fruit also largely varied among the species or individuals. Hermaphrodity and self fruitfulness found *in A. rufa* is very unique trait in *Actinidia* species those are commonly dioecious. Chilling requirement for breaking dormancy, tolerance to the environmental stress such as drought, water logging, high temperature are being investigated for these native species.

Fruit of *A. arguta*. The vines are used as the material for suspension bridge.



Ploidy variation and geographic localization of *A. arguta*

2. Breeding of kiwifruit utilizing native species

For the purpose of diversifying the characteristics of kiwifruit, breeding programs have been conducted utilizing the native species. 'Kagawa UP-KI 1-5' ("Sanuki Kiwicco ®") registered in 2014 are the small-fruited cultivars with high tasting quality and productivity selected from the interspecific cross seedlings between *A.rua* and *A.chinensis* kiwifruit. Breeding program objecting the red coloration of flesh, self-fruitfulness, disease resistance, tolerance to the environmental stress due to climatic change by the global warming are in progress.

Interspecific hybrid cultivar between *A.rufa* and *A.chinensis* kiwifruit (Sanuki Kiwicco®)

Publications

・Ploidy variation of hardy kiwifruit (*Actinidia arguta*) resources and geographic distribution in Japan. Scientia Horticulturae. 124:409-414, 2010, Kataoka, I., Mizugami, T., Kim J. G., Beppu, K. *et al.*

・Identification of hermaphroditism and self-fruitfulness in the wild Actinidia found in warm region of Japan, 12, 361-366.2013, Matsumoto, H., Beppu, K. and Kataoka, I. . (in Japanese)

・Selection of low-chill kiwifruit adapting to warm climate by utilizing *Actinidia rufa* native to southwestern part of Japan, Acta Horticulturae, 1059, 85-88, 2014, Kataoka, I. *et al.*

・Variety Registration, Kiwifruit, KAGAWA UP-KI1-5 (*Actinidia* Lindl.), Registration No. 23671-23675, 2014

Research Area: Horticultural Science
Research Specialization: Horticultural breeding
Name: TAKAMURA, Takejiro

Keywords: **Flower color, Flower pigment, inter-specific hybridization, polyploidy breeding**

Recent Research

1. Genetic control and improvement of flower-color expression in cyclamen

Although petal color of cyclamen was red, purple, white, and their neutral tint until the 1980s, the yellow-flowered cultivars and individuals with bluish-violet petals in cyclamen are available now. We have clarified the main factor causing the bluish-violet petals and inheritance of the yellow-flowered characteristics. We presently study the mechanism of cyclamen petals becoming bluish color, expression of anthocyanin and flavonoid synthesis-related gene in cyclamen, and so on.

2. Interspecific hybridization and polyploidy breeding in the genus *Cyclamen*

The genus *Cyclamen* contains more than 20 species. Almost all the species, except *C. persicum*, have not contributed to the breeding of horticultural cyclamen cultivars, whereas some *Cyclamen* species have useful characteristics. In our laboratory, interspecific hybridization by using such *Cyclamen* species is studied. Polyploidy breeding by using such species and interspecific hybrids is also researched.

3. Analyses of mechanisms of pigmentation and flower-color expression in some ornamental plants

Mechanisms of flower-color expression and pigmentation in some ornamental plants (e.g., Persian buttercup and glory lily) are studied. Effects of environmental factors on the flower-color expression and pigmentation in some ornamental plants are also researched.

Publications

Takamura, T. : Cyclamen, Flower Breeding & Genetics: Issues, challenges, and opportunities for the 21st century (N. O. Anderson ed.), 459-478, Springer-Verlag, Dordrecht (2006) .

Takamura, T. *et al.*: Ploidy levels of degenerated embryos in the crosses between diploid and tetraploid cyclamen, Acta Horticulturae 855 ,261-266 (2010).

Takamura, T. *et al.*: Effects of CO_2 enrichment on in vitro plant regeneration through somatic embryogenesis in cyclamen (*Cyclamen persicum* Mill.) Technical Bulletin of Faculty of Agriculture, Kagawa University 62, 1-4 (2010).

Takamura, T. *et al.* : Effect of carbon source on *in vitro* plant regeneration in anther culture of cyclamen (*Cyclamen persicum* Mill.). Acta Horticulturae 923: 129-134 (2011) .

Research Area: Horticultural Science
Research Specialization: Floriculture
Name: FUKAI, Seiichi

Keywords : genetic resources, flowering, postharvest of cut flower

Recent Research

1. Evaluation, preservation and utilization of genetic resources in floriculture

Diversity is one of important characteristics of ornamental plants. There are many unused genetic resources in the world. In order to create new varieties using them, it is required to evaluate it as a genetic resource, to utilize it through crossing breeding, and to develop the method of stable preservation of those genetic resources.

Currently we are studying on the utilization and preservation of genetic resources in *Torenia*, *Habenaria* and some wild chrysanthemums having self-compatibility and male sterility.

2. Postharvest of cut flowers

In flower production, technology is required to produce the flowers that fully demonstrate the potency of the variety and deliver it to consumers without degrading the quality.

Currently, we are studying on carnation having unstable flower coloration through relationship between the genes involved in flower color development and the environment conditions. We are also studying on post-harvest quality management of cut flowers.

3. Flowering physiology

Various genes are involved in flowering. If the function of flowering genes and the mechanism of flower formation are clarified, it is possible to control the process of flower blooming. If we know what kind of information the plants are going to obtain from the environment to start blooming, we can use it to make flowering control possible.

Currently we are studying on flowering physiology of chrysanthemum and flowering control of some bulb plants.

Publications

Fukai,S., Y. Monden, T. Narumi and E. Kodaira. Seed propagation of *Colchicum capense* subsp. *cilioratum*. Propagation of Ornamental Plants 13, 51-56 (2013).

Higuchi, Y., T. Narumi, A. Oda, Y. Nakano, K. Sumitomo, S. Fukai, T. Hisamatsu. The gated induction system of a systemic floral inhibitor, antiflorigen, determines obligate short-day flowering in chrysanthemum. PNAS 111, 17137-17142, 2013 (2013)

Fukai, S. Flowering physiology of chrysanthemum. Acta Hort.1025,135-142 (2014)

Fukai, S. Seed Production and Germination in *Echinocactus horizonthalonius* (Cactaceae). Proceedings International symposium on botanical gardens and landscape. p.101-107 (2014)

Sinumporn, P., S. Fukai, T. Narumi and N. Potapohn.New usage of *Habenaria radiata* as a cut flower. Acta Hort. 1078, 193-200, 2015.

Fukai, S., Development of cryopreservation techniques in ornamental crops. Acta Hort.(in press)

Laojunta, T., T. Narumi-Kawasaki and S. Fukai, Characteristics of commercial *Torenia* cultivars. Acta Hort. (in press)

Research Area: Horticulture
Research Specialization: Pomology
Name: BEPPU, Kenji

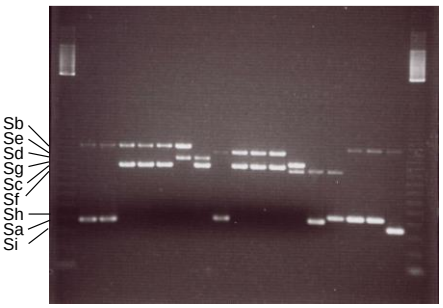
Keywords: peach, plum, cherry, reproductive physiology, breeding

Recent Research

1. Breeding and utilization of lower-chilling peach

Forcing culture of peach under plastics is intended to ensure early shipping of production aimed at obtaining a higher market value. Usually, peach growers start forcing after attaining 900 chilling hours required by the high-chill cultivars. For achieving earlier forcing, lower-chilling peach with a high tasting quality would be necessary. Therefore, we bred a new cultivar named 'KU-PP1' and 'KU-PP2' that contained these traits by crossing Japanese high-chill and introduced low-chill cultivars. Currently we investigate effective methods for forcing culture with these cultivars.

2. Breeding of self-compatible Japanese plum



Most commercial cultivars of Japanese plum are self-incompatible and cross-compatible cultivars need to be interplanted. Thus, information about *S*-haplotypes of each cultivar is important. We demonstrated that the *S*-RNase genes of Japanese plum could be amplified effectively by *S*-RNase gene-specific primers, and identified 14 different *S*-RNase genes. In addition, we revealed the involvement of the S^e-haplotype in self-compatibility in Japanese plum and developed the S^e-RNase gene-specific primer. Currently, we are breeding self-compatible Japanese plum cultivars with good fruit quality.

3. Regulation of fruit set of sweet cherry in warm region

Poor fruit set due to physiological fruit drop have become serious problems preventing stable production of sweet cherry in warm regions. Under controlled conditions, we demonstrated that the fruit set rate decreased markedly due to the rapid degeneration of the embryo sacs when the trees were exposed to high temperatures above 20 ℃, and that gibberellin may be involved in this phenomenon. We also found that extremely high temperature in summer reduced photosynthesis and cause early defoliation, which result in low fruit set rate in the following spring. We have developed several methods to improve fruit set in warm regions.

Publications

Beppu, K. and Kataoka, I. (2016) Registration of new plant varieties, Peach, 'KU-PP2' (*Prunus persica* (L.) Batsch), Registration number: 24983.

Beppu, K. et al. (2014) Examination of time of heating in forcing culture of lower-chilling peach selection HKH×FLP3, Acta Hort. 1059, 201-204.

Beppu, K. et al. (2012) Molecular and genetic analyses of the *S*-haplotype of the self-compatible Japanese plum (*Prunus salicina* Lindl.) 'Methley', J. Hort. Sci. Biotech. 87, 493-498.

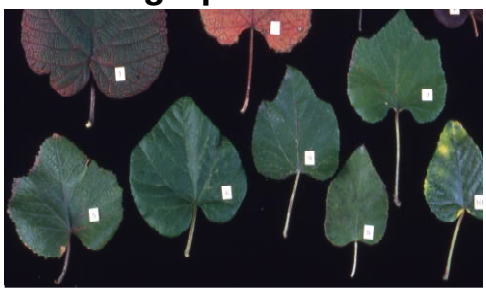
Beppu, K. and Kataoka, I. (2011) Studies on pistil doubling and fruit set of sweet cherry in warm climate, J. Jap. Soc. Hort. Sci. 80, 1-13.

Research Area: Horticultural Science
Research Specialization: Pomology
Name: MOCHIOKA, Ryosuke

Key words：***Vitis*, wild grape, breeding, coloration**

Recent research

1. Research of habitat, collection, and evaluation of wild grapes native to Japan



15 wild grapes are identified in Japan, but just *Vitis coignetiae* was utilized. We have been collecting various wild grapes over the different places in Japan, and researching their characteristics. As a result, we clarified some of them have some good characteristics (e.g. no bud dormancy, good skin coloration even under the high temperature, high sugar content, ever-bearing).

2. Breeding the new grape cultivars with good skin coloring even under high temperatures in the warm areas

Plant pigments can express with sugars. Therefore, low sugar contents in fruits make fruit skin color worse. As the climate of Seto Inland Sea shows many hot summer days and tropical nights in summer, there are some serious problems about skin coloring there. We bred the new wine cultivar ‘Kadainou R-1’ using with *Vitis ficifolia* var. *ganebu* distributed in the subtropical regions in Japan. ‘Kadainou R-1’ has a lot of functional substances (anthocyanin, polyphenol, flavonol etc.), and the taste of wine made from this cultivar is not bitter but light.

Publications

・Polyphenolic diversity and characterization in the red-purple berries of East Asian wild *Vitis* species. Phytochemistry 134: 78-86 . 2017. Koyama, K., H. Kamigakiuchi, K. Iwashita, **R. Mochioka**, N. Goto-Yamamoto.

・Distribution of *Vitis flexuosa* Thunb. , wild grape native to Japan, in Okinawa Island. Journal of ASEV Japan27：105-110. 2016. **Mochioka,R.**

・The registration of the new red wine cultivar 'Kadainou R-1‘. Technical Bulletin of Faculty of Agriculture, Kagawa University66：5－16. 2014. **Mochioka, R.**

・ ‘KadainouR-2’. The registered wine grape cultivar of MAFF. No/25537. 2016. **Mochioka, R.**

・ ‘KadainouR-1’. The registered wine grape cultivar of MAFF. No.13646. 2006. **Mochioka, R.**

Research Area: Horticaultural Science
Research Specialization: Greenhouse production
Name: YANAGI, Tomohiro

Keywords : Strawberry, Chromosome, Breeding, DNA analysis

Recent Research

1. DNA analysis using chromosome microdissection in strawberry

Cultivated strawberry has homoeologous chromosomes because of allo-octoploidy. For example, two homoeologous chromosomes that belong to different sub-genome of allopolyploids have similar base sequences. Thus, when conducting de novo assembly of DNA sequences, it is difficult to determine whether these sequences are derived from the same chromosome. To avoid the difficulties associated with homoeologous chromosomes and demonstrate the possibility of sequencing allopolyploids using single chromosomes, we conducted sequence analysis using microdissected single somatic chromosomes of cultivated strawberry.

Three hundred and ten somatic chromosomes of the Japanese octoploid strawberry 'Reiko' were individually selected under a light microscope using a microdissection system (Fig. 1). DNA from 288 of the dissected chromosomes was successfully amplified using a DNA amplification kit. Using next-generation sequencing, we decoded the base sequences of the amplified DNA segments, and on the basis of mapping, we identified DNA sequences from 144 samples that were best matched to the reference genomes of *Fragaria* × *ananassa and Fragaria vesca*. The 144 samples were classified into seven pseudo-molecules of *F. vesca* (Fig. 2*)*.

We demonstrate an efficient method for sequence analysis of allopolyploid plants using microdissected single chromosomes. On the basis of our results, we believe that whole-genome analysis of allopolyploid plants can be enhanced using methodology that employs microdissected single chromosomes.

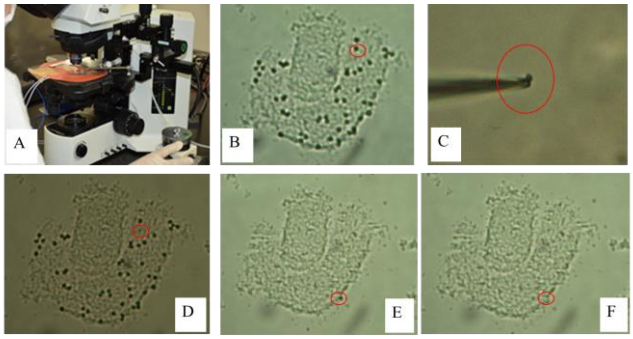


Fig. 1 The equipment used for chromosome microdissection and some pictures of chromosome and somatic cells of the cultivated strawberry. (A) Microdissection equipment which was used in the present experiment, (B) Chromosome image of the cultivated strawberry; the red circle shows the chromosome which will be selected, (C) A single dissected chromosome on the glass needle, (D) The chromosome in B is disappeared, (E) The red circle shows the final chromosome of the somatic cell, and (F) All chromosomes were selected in the somatic cell.

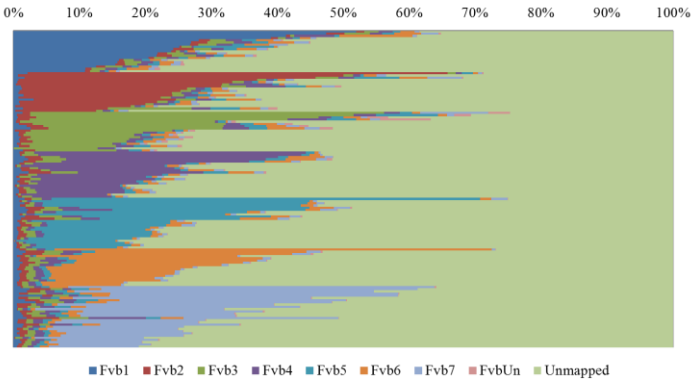


Fig. 2 The results of mapping onto pseudo-molecules of *F. vesca* (*2n = 14*), that is one of the genome donors in the cultivated strawberry. The DNA segments that were obtained from a micro-dissected single chromosome, decoded the sequences by the NGS. Every DNA sequence was classified into FvB1 to FvB7 of pseud-molecules in *F. vesca*, FvUn of unassigned sequence in *F. vesca* and unmapped one. The percentage of the reads in every pseud-molecular were calculated, and sorted according to the higher order of the Fvb1 to Fvb7. Then the data were summarized in this figure. Each thin bar exhibited the data of each sample.

Publications

Strawberry (Plants in the genus *Fragaria*); In: Polyploidy and Hybridization for Crop Improvement, CRC Press, 115-158, 2016, **Yanagi, T.** and Noguchi, Y.

・Effects of light quality and quantity on flower initiation of *Fragaria chiloensis* L. CHI-24-1 grown under 24 h day-length, Scientia Horticulturae, 202, 137–140, 2016, **Yanagi, T.**, Okamoto, K., and Okuda, N.

・Effect of insect pollinator on inbreeding versus outbreeding in open pollinated strawberry seeds，査読有，Scientia Horticulturae, 215: 112-116, 2017, **Yanagi, T.**, Miura, H., Isobe, S., Okuda, N., and Yoshida, Y.

・The development of a primed in-situ hybridization technique for chromosome labeling in cultivated strawberry *(Fragaria* × *ananassa*) , Cytoligia 81 439-446, 2017, Tantivit, K., Isobe, S., Nathewet, P., Okuda, N., and **Yanagi, T.**

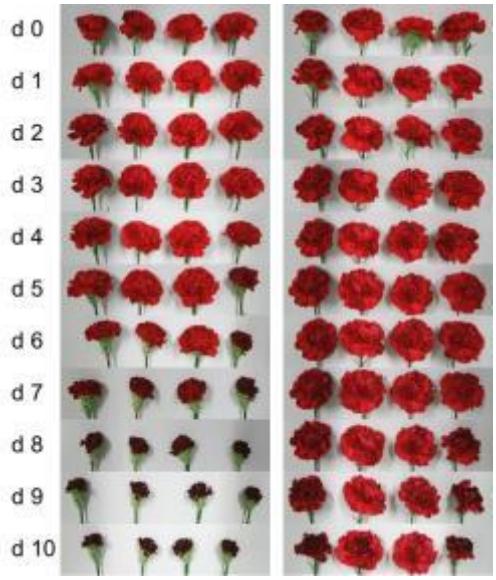
・CAPS DNA Marker Labeling Using Primed in Situ (PRINS) Hybridization Technique for Chromosome of Strawberry (*Fragaria* × *ananassa* Duch.) , International Journal of Fruit Science, 17, (in press), 2017, Tantivit, K., Nathewet, P., Okuda, N. and **Yanagi, T.**

Research Area: Horticultural Science
Research Specialization: Postharvest Horticulture
Name: KOSUGI, Yusuke

Keywords: postharvest quality, flower longevity, senescence, ethylene (as a plant hormone), gene expression

Recent Research

Most of horticultural produce (fruits, vegetables and ornamentals) easily deteriorate after harvest and lose their commercial value. We conduct basic studies that focus on the mechanisms inducing the postharvest deterioration. We mainly work on the flower senescence in ornamental plants including cut flowers.

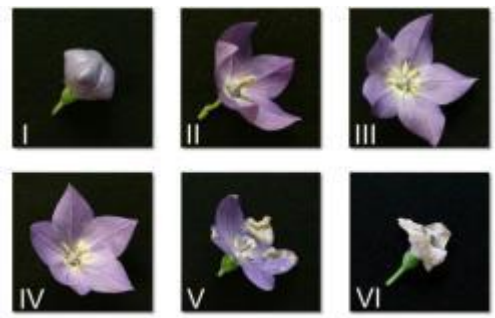


1. Substances that improve vase-life of cut flowers

The plant hormone ethylene play a crucial role in inducing flower senescence in many ornamental plants. Carnation (*Dianthus caryophyllus* L.) is one of the major cut flower items, and the flowers show ethylene-dependent senescence. We examine the effect of new substances as inhibitors of ethylene biosynthesis, and evaluate them as potential preservatives for the cut flowers.

2. Identification of genes responsible for flower longevity

Petal wilting is one of key events determining flower longevity in ornamental plants. To understand the molecular basis governing petal wilting, we isolate and analyze the genes associated with the process in carnation and balloon flower (*Platycodon grandiflorus* (Jacq.) A. DC.), both of which show flower senescence with their petals (corollas) wilting severely.



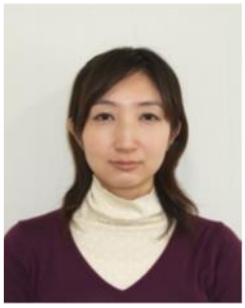
Publications

・2-Aminooxyisobutyric acid inhibits the *in vitro* activities of both 1-aminocyclopropane-1-carboxylate (ACC) synthase and ACC oxidase in ethylene biosynthetic pathway and prolongs vase life of cut carnation flowers, Journal of Plant Biology, **57**, 218-224, 2014, **Kosugi, Y**., Matsuoka, A., Higashi, A., Toyohara, N., Satoh, S.

・2,4-Pyridinedicarboxylic acid prolongs the vase life of cut flowers of spray carnations, Japanese Society for Horticultural Science, **83**,72–80, Satoh, S., **Kosugi, Y.**, Sugiyama, S., Ohira, I.

・*Escherichia coli*-based expression and *in vitro* activity assay of 1-aminocyclopropane-1-carboxylate (ACC) synthase and ACC oxidase. *In* Ethylene Signaling: Methods and Protocols. Edited by Binder, B.M. and Schaller, G.E. pp.47-58, 2017, Humana Press, Satoh, S. and **Kosugi,Y.**

Research Area: Horticultural Science
Research Specialization: Floriculture
Name: NARUMi, Takako

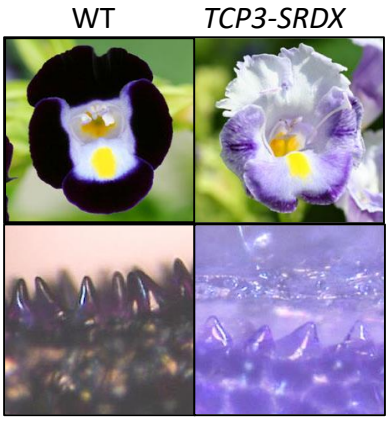


Keywords: ornamental plant, petal epidermal cell, floral morphogenesis, flowering

Recent Research

1. Identification of novel petal epidermal cell-related gene

Flower color is determined not only pigments but also the shape of petal epidermal cells, which influence the tone and texture of petals owing to the different reflection and refraction of light. We revealed that the known petal epidermal cell-related genes are not main factor though those have been identified in snapdragon and torenia. Therefore, we have performed identification of novel petal epidermal cell-related gene by RNA-seq analysis of torenia.



2. The effects of temperature on flowering

The recent high temperature during the summer and fall months has known to cause flowering delay in marguerite. We study about flowering characteristics in marguerite of a specialty of Kagawa Prefecture through flowering response by light or temperature control and flowering-related gene analysis.

3. The others

- Elucidation of regulation mechanisms of floral zygomorphy in torenia
- Molecular mechanisms of flower color mutation derived from bud mutation of carnation

Publications

Narumi, T. et al. (2007) Chimeric *AGAMOUS* repressor induces serrated petal phenotype in *Torenia Fournieri* similar to that induced by cytokinin application. Plant Biotechnology, 25: 45-54.

Narumi, T. et al. (2011) *Arabidopsis* chimeric TCP3 repressor produces novel floral traits in *Torenia fournieri* and *Chrysanthemum morifolium*, Plant Biotechnology, 28: 131-140.

Sasaki, K. et al. (2011) Utilization of a floral organ-expressing AP1 promoter for generation of new floral traits in *Torenia fournieri* Lind, Plant Biotechnology, 28: 181-188.

Oda, A. et al. (2012) *CsFTL3*, a chrysanthemum *FLOWERING LOCUS T-like* gene, is a key regulator of photoperiodic flowering in chrysanthemums. J. Exp. Bot. 63: 1461-1477.

Higuchi,Y. et al. (2013) The gated induction system of a systemic floral inhibitor, antiflorigen, determines obligate short-day flowering in chrysanthemums PNAS 110, 17137–17142,

Research Area: Environmental & Ecological Sciences
Research Specialization: Coastal Marine Science
Name: ICHIMI, Kazuhiko

Keywords: coastal environment, estuary, tidal flat, biological production

Recent Research

1. Function of inter tidal areas in coastal sea

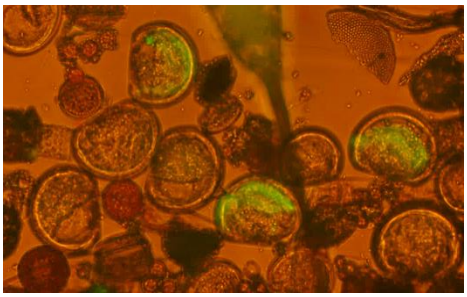
Inter tidal flat is located at the boundary between land and coastal sea, where various organisms inhabit and biological productivity is very high. Tidal flat strongly decomposes organic substances brought from river and coastal waters. We aim to quantitatively evaluate the role of intertidal zone such as biological productivity and material circulation processes in coastal environments.

2. Ecology and applied phycology of high-growth diatoms

We found a diatom which has extremely high growth speed. The diatom (*Chaetoceros* sp.) grow more than 1000 times in one day under high water temperature and high light intensity. We are searching for use in various fields such as important primary producer in the field, food for the fishery organisms, application for energy supply and importance for gene resource.

3. Elucidation of cause for the drastical decrease in bivalves

Manila clam is a very important species as a fishery organisms in our country, but now the resource tends to decrease, especially in western Japan. We are continuing to monitor the clams in the Seto Inland Sea concerning to planktonic larvae, junenile and adult shellfish.



Publications

Ichimi, K., Kawamura, T., Yamamoto, A., Tada, K., and Harrison, P. J. (2012) Extremely high growth rate of the small diatom *Chaetoceros salsugineum* isolated from an estuary in the eastern Seto Inland Sea, Japan. Journal of Phycology **48**: 1284-1288.

Kuwae, T., Miyoshi, E., Hosokawa, S., Ichimi, K., Hosoya, J., Amano, T., Moriya, T., Kondoh, M., Ydenberg, R. C., and Elner, R. W. (2012) Variable and complex food web structures revealed by exploring missing trophic links between birds and biofilm. Ecology Letters **15**: 347-356.

Ichimi, K., Sumimoto, H., Nakayama, H. and Tada, K. (2011) Effect of nutritional level on the standing stock and biodiversity of macrobenthos in tidal flat ecosystems and human fishing pressure on the standing stock of short-neck clam. Bulletin on Coastal Oceanography **48**: 109-116**.** (in Japanese with English abstract)

Ichimi, K., Hamaguchi, K., Yamamoto, A., Tada, K. and Montani, S. (2011) Retention and release system of phosphorus in Shinkawa-Kasugagawa River Estuary in the western part of Japan. Bulletin on Coastal Oceanography **48**: 167-178. (in Japanese with English abstract)

Research Area: Environmental Science
Research Specialization: Insect Ecology
Name: ITO, Fuminori

Keywords: Ant, Diverstiy, Social structure, Invasive species, Tropical Asia

- Recent Research
- 1 Diversity of caste dimorphism in ants

Loss of flight in ants permitted extensive changes in body size of workers and queens: workers can be very small whereas queens become huge. Such remarkable caste dimorphism may affect several aspects of biology. Especially queen behavior, and interactions between workers and queens may vary according to the degree of dimorphism.

Huge queen and small worker in *Cladomyrma sirindhornae*

2 .Biology of invasive exotic ants

Argentine ants attending aphids

The occurrence of Argentine ants in Japan was firstly reported in Hiroshima in 2000. To understand the change of distribution of Argentine ants and the effects of the invasive ants on native ant fauna, we established 77 plots in and around Hatsukaichi-city in 2000, and ant fauna in these plots has been investigated every year. In addition, interactions between Argentine ants and native organisms are also studied.

3 .Ant species diversity in the Oriental tropics

Species diversity of ants has been investigated in Ulu Gombak, Peninsular Malaysia from 1992. So far more than 400 species of ants are collected from this place. Beside faunal survey, ecology and behavior of ant species in Ulu Gombak are studied.

Crematogaster inflate and its mimic, *Camponotus* sp.

Publications

Ito, F., et al (2001) Ant species diversity in the Bogor Botanic Garden, West Java, Indonesia, with descriptions of two new species of the genus *Leptanilla* (Hymenoptera, Formicidae), Tropics 10, 379-404

Ito F, Hashim R, Yek SH, Kaufmann E, Akino T, Billen J (2004) Spectacular Batesian mimicry in ants. Naturwissenschaften 91:481–484

Ito, F., Touyama, Y., Gotoh, A., Kitahiro, S. and Billen, J. (2010) Thelytokous parthenogenesis by queens in the dacetine ant *Pyramica membranifera*. Naturwissenschaften, 97:725-728

Peeters C, Ito F (2015) Wingless and dwarf workers underlie the ecological success of ants (Hymenoptera: Formicidae). Myrmecological News 21: 117-130

Research Area: Environmental & Ecological Science
Research Specialization: Chemical and Biological Oceanography
Name: TADA, Kuninao

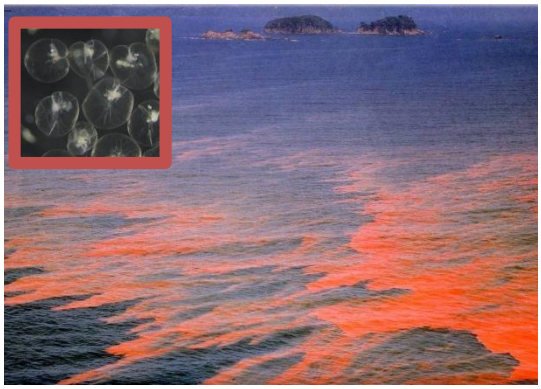
Keywords：Coastal water, Nutrient, Phytoplasnkton, Seto Inland Sea,Sediment

Recent Research

1. Nutrient decrease in the Seto Inland Sea and nutrient control in the future

During high economic growth of the 1960s and thereafter, the Seto Inland Sea, Japan was heavily eutrophicated, and red tide occurred often. To resolve the situation, the Law for Conservation of Environment of Seto Inland Sea was enacted in 1973 to regulate industrial effluent and urban wastewater. With the enactment of this law, the annual occurrence of red tides in the Seto Inland Sea decreased from 300 to 100.However, with changes in nutrient levels, the fisheries yields of species such as sardine and short-neck clam were affected negatively. Also, seaweed Nori culture was heavily damaged. How can we control the nutrient level? We investigate the nitrogen and phosphorous cycle in the coastal environment. We are studying about N and P loading from the land, and the behavior of N and P in the seawater and bottom sediment.

2. The ecology of *Noctiluca scintillans*



Noctiluca scintillans red tide is the most frequent in all red tide outbreaks in the Seto Inland Sea. The biomass of *N.scintillans* is not trivial as it occupies a substantial part of the plankton biomass, even when *N.scintillans* red tide has not occurred. We are studying about the variation in abundance of *N.scintillans* and its ecological role in the coastal water.

Publications

Tada, K., et al. (1998): Standing stocks and production rates of phytoplankton and abundance of bacteria in the Seto Inland Sea, Japan. Journal of Oceanography **54**, 285 – 295.

Tada, K. et al. (2000): Carbon and nitrogen content of *Noctiluca scintillans* in the Seto Inland Sea, Japan. Journal of Plankton Research **22**, 1203 – 1211.

Tada, K., et al. (2004): Seasonal variation in the abundance of *Noctiluca scintillans* in the Seto Inland Sea, Japan. Plankton Biology and Ecology, **51**, 7-14.

Tada, K. et al. (2009) : Diatoms Grow Faster Using Ammonium in Rapidly Flushed Eutrophic Dokai Bay, Japan.. Journal of Oceanography, **65**, 885 – 891.

Nishikawa, T. et al. (2010) : Nutrient and Phytoplankton Dynamics in Harima-Nada, Eastern Seto Inland Sea, Japan During a 35 Year Period from 1973 to 2007. Estuaries and Coast, **33**, 417 – 427.

Asahi, T. et al. (2014): Horizontal distribution of particulate matter and its characterization using phosphorous as an indicator in surface coastal water, Harima-Nada, the Seto Inland Sea, Japan, Journal of Oceanography, 70, 277 – 287.

多田ら（2014）：瀬戸内海東部海域の栄養塩異変とその影響，沿岸海洋研究，**52**，39−47.

Tada, K.,et al. (2017).: Negligible effect of the benthic fauna on measuring the nutrient upward fluxes from coastal sediments, Journal of Oceanography, 73, 397-402 .

Area of Specialization: Environmental & Ecological Sciences
Study field: Water Environmental Science
Name: YAMADA, Yoshihiro

Key ward: water resources, material circulation, ecosystem, stable isotope

Recent Research

1. Study on the relationship between water use and environment in a basin with poor water resources.

The uneven distribution of precipitation caused by global warming is expected to intensify, mainly in Asia and Oceania, including Japan. In areas of reduced precipitation, more efficient water use will be required for food production. Therefore, it is necessary to have an understanding of the proper use of water, and to study ways of sustainable utilization of water, and biological resources. In this study, we analyzed water and material circulation at the basin scale for the watershed of the Seto Inland Sea Region, which has poor water resources. We elucidated the mechanism of water pollution / ecological alteration from river to marine areas caused by water use in terrestrial areas. Based on the results obtained, we aimed to present a water use system for sustainable biological production, which imposes a smaller burden on natural substance circulation and ecosystem.

2. Study of interrelationship between water circulation in the basin and the food chain in coastal waters.

Organic pollution in the basin significantly changes the composition of substances transported by the river to the coastal areas. There is a relative decrease in the nutrients necessary for primary production in the sea, and a relative increase in the organic matter in the form of freshwater algae. This change disturbs the biological production and food chain in the coastal waters. In this study, we quantitatively analyzed the dynamics (predation, decomposition, and outflow) of freshwater algae in rivers, tidal flats, and coastal waters. Further, we quantitatively clarify the contribution of freshwater algae in the food chain in the Seto Inland Sea. Thereafter, we proposed a mechanism to balance biological production between land and ocean areas.

3. Development of Assessment method of Water Environment - Water / Substance Environment Map.

Conventionally, physical parameters, such as water temperature and water level have been used in water circulation research. Recently, however, tracer technologies using various stable isotopes and major/trace elements have been proposed. Using these substances as tracers enables the effective tracing of water circulation processes and substance dynamics. The feature of this research is that it integrates various traceability methods and practices to monitor basin water conservation.

Publications

Yamada, Y., Fukuda, T., Omori, K., Nakano T.: Origin of particulate organic matter in river with remarkable water pollution in Shikoku Island, Japan, *Limnology* 16, 127-137, 2015.

Fukuda, T., Nozaki, K., Yamada, Y.: Contribution of Phytoplankton to River Organic Pollution in the Basin with Scarce Water Resource: *Ecology and Civil Engineering* 17, 89-99, 2015.

Yamada, Y., Mito, Y, and Nakashima S.: Organic pollution in dammed river water in a low precipitation region of Japan, *Limnology* 11, 267-272 (2011).

Research Area Environmental Science
Research Specialization Plant Ecology
Name KOBAYASHI, Tsuyoshi

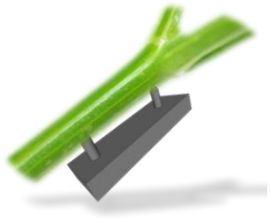
Keywords : terrestrial higher plants, matter production, bamboo, sensor

Recent Research

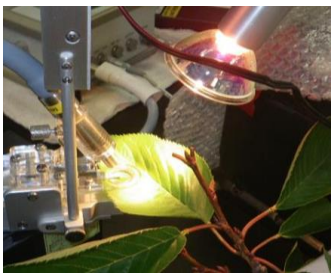
1. Bamboo invasion on ecosystem structure and function

- Moso bamboo invasion processes in secondary rural forests in western Japan
- Stand and population growth/decline in the bamboo forests
- Carbon cycling in the bamboo ecosystems
- Photosynthesis, water use and microclimates of bamboo canopy

2. Microsensor to measure xylem and phloem flows of higher plants



- Construction of microscale sap/phloem flow sensors (cf. MEMS technology in Faculty of Engineering, Kagawa University)
- Tests to survey water and photosynthate transport system at wholeplant level
- System development to monitor and control water and carbon dynamics in agricultural and natural fields



3. Others

- Life history and ecophysiology in weeds and endangered plants
- Effects of acidic depositions and rare sugars on plant growth and reproduction

Click here for more information.

Publications

Ichihashi R, **Kobayashi T** (2017) Growth and photosynthesis characteristics of invading larch saplings in an occasionally flooded dry stream bed in cool-temperate Japan. *Journal of Forest Research* (in press).

Kobayashi T, Taneda H (2016) Measuring and analyzing techniques of xylem- and phloem-flows for higher plants from anatomy to ecosystem scale. *Japanese Journal of Ecology* **66**: 439-544. (in Japanese)

Shimokawa F, Takao H, Suzuki T, **Kobayashi T**, Kataoka I (2016) Plant moisture movement state sensor. International Patent, 2015JP000325･WO2015115084

Kobayashi T, Fukushima K, Hisamoto Y, Inoue A (2015) The species biology of bamboos in Japan: from gene to landscape. *Plant Species Biology* **30**: 42-115.

Research Area: Environmental Science
Research Specialization: Evolutionary Ecology
Name: YASUI, Yukio

Key words: evolution, adaptation, sexual selection, mating behavior

Recent Researches

1. *Adaptive significance of insect characters*

Organisms have evolved many adaptive characters to fit their environments. Genetic variation exists in any characters in species population and the genes coding adaptive characters will increase in frequency in the population through generations. This is natural selection, the evolutionary process advanced by Charles Darwin (1859). In Yasui Laboratory, we study adaptive strategies of insects and other arthropods. In particular, we are exploring adaptive significance and evolutionary function of insect coloration. Why are butterflies so beautiful? – It cannot be easily explained unlike bird ornaments because female butterflies do not choose mates based on male ornaments. We are also interested in the conservation of world insect faunas and biodiversity of Japanese "Satoyama" environments.

2. *The evolution of female multiple mating or polyandry*

In general, male fitness is mainly limited by the number of mates, whereas female fitness is fundamentally limited by the number of ova. Thus, sexual selection theory predicts that males tend to mate promiscuously and females should choose only one mate and invest in a limited number of offspring. However, the females of many animal species mate with more than one male in a reproductive season (polyandry). The evolution of polyandry is one of the largest enigmas not only in animal behavior but also in regard to the origin of human nature.

We are testing several hypotheses to explain polyandry such as "good sperm" process, genetic incompatibility or bet-hedging (risk-spreading) using crickets (white eye and black eye strains).

Publications

Yasui, Y. 1997. A "good-sperm" model can explain the evolution of costly multiple mating by females. *The American Naturalist* 149: 573-584. http://www.jstor.org/stable/2463384?seq=1#page_scan_tab_contents

Yasui, Y. 1998. The 'genetic benefits' of female multiple mating reconsidered. *Trends in Ecology and Evolution* 13: 246-250. http://www.sciencedirect.com/science/article/pii/S0169534798013834

Yasui, Y. 2001. Female multiple mating as a genetic bet-hedging strategy when mate choice criteria are unreliable. *Ecological Research* 16: 605-616. http://onlinelibrary.wiley.com/doi/10.1046/j.1440-1703.2001.00423.x/full

Garcia-Gonzalez, F., Yasui, Y. and Evans, J. P. 2015. Mating portfolios: bet-hedging, sexual selection and female multiple mating. *Proceedings of the Royal Society of London. Series B. Biological Sciences*. vol.282 http://dx.doi.org/10.1098/rspb.2014.1525

Yasui, Y. and Garcia-Gonzalez, F. 2016. Bet-hedging as a mechanism for the evolution of polyandry, revisited. *Evolution* 70: 385-397. http://onlinelibrary.wiley.com/doi/10.1111/evo.12847/abstract

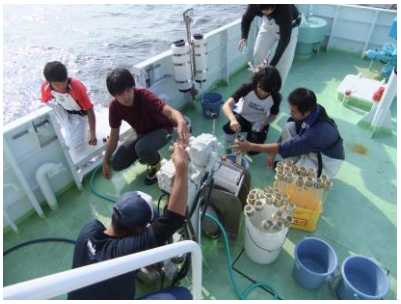
Research Area: Environmental and Ecological Sciences
Research Specialization: Coastal Biogeochemistry
Name: YAMAGUCHI, Hitomi

Keywords:
coastal ecosystem, light, nutrient, phytoplankton, microphytobenthos, field study

Recent Research

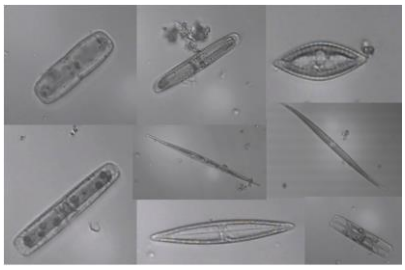
・Light, nutrient, and phytoplankton dynamics in the Seto Inland Sea

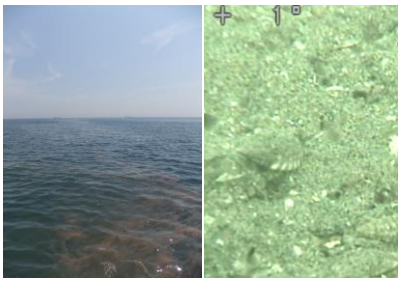
The focus of my research is to understand light and nutrient environments in coastal areas, and how do phytoplankton respond to and control changes in these environments. The primary target area for research is the Seto Inland Sea (SIS), which has one of the highest fishery yields per unit area in the world. I seek to understand the underlying mechanisms to support the high fishery yields in the SIS. I am a field-based biogeochemical oceanographer focusing on coastal areas. Hence, the studies are mainly based on research cruises to estuarine, coastal and shelf areas.



・Biogeochemical role of microphytobenthos in coastal ecosystems

Parts of coastal areas, where light often reaches to the seafloor, sustain benthic primary production. Most of sandy and muddy seafloor in such areas looks barren at first glance, yet microphytobenthos (benthic microalgae) universally inhabit there. Our laboratory is focused on elucidating of biogeochemical role of microphytobenthos in coastal areas. The topics include quantification of the biomass and production and understanding of its regulating factors, the contribution to nutrient cycling and coastal food web, etc. I am also interested in ecophysiological responses to light and nutrient availability of microphytobenthos. The aim of research is to understand the functioning of coastal ecosystems through the comparative or interaction study of microphytobenthos and phytoplankton.





Publications

・Light and nutrient limitation on phytoplankton production in the strait of an enclosed sea (Bisan Strait, eastern Seto Inland Sea, Japan), J. Sea Res., **103**, 75, 2015, **Yamaguchi, H.**, Hirade, N., Higashizono, K., Tada, K., Kishimoto, K., Oyama, K., Ichimi, K.

・Optically active components and light attenuation in an offshore station of Harima Sound, eastern Seto Inland Sea, Japan. Hydrobiologia, **714**, 49, 2013, **Yamaguchi, H.**, Katahira, R., Ichimi, K., Tada, K.

・Dynamics of microphytobenthic biomass in a coastal area of western Seto Inland Sea, Japan. Est. Coast. Shelf Sci., **72**, 348, 2007, **Yamaguchi, H.**, Montani, S., Tsutsumi, H., Hamada, K., Ueda, N., Tada, K.

Research Area: Environmental Science
Research Specialization: Soil Ecology
Name: TOYOTA, Ayu

Keywords: soil invertebrates, litter decomposition, soil organic matter, millipedes, ecosystem engineers, soil nutrient availability

Recent Research

1. Roles of soil macroinvertebrates on nutrient cycle between soil and plants

Soil macroinvertebrates, such as earthworms and millipedes, affect primary litter decomposition and nutrient dynamics in soil ecosystem. The study addresses the role of soil macroinvertebrates community and litter quality on soil nutrient availability for plants.

2. Changes in stability of soil organic matter by soil macroinvertebrates

Accumulation of organic matter in soils can be regulated by soil macroinvertebrates at smaller spatial scales (local scales). To determine the long-term soil organic matter storage caused by soil macroinvertebrate, I investigate the consequences of the invertebrate behavior, focusing in particular on molting chamber of the train millipede in Japan.

Molting chamber

3. Soil management for sustainable production

To detect signs of soil ecosystem changes associated with climate changes or artificial disturbances, I conduct environmental monitoring surveys. I will also approach to evaluate the predictable sustainability in soils based on temporal variation pattern analysis of environmental factors. The goal of this study is to provide the information for soil management and practical conservation.

Publications

Toyota, A., Hynšt, J., Cajthaml, T., Frouz, J. (2013) Soil fauna increase nitrogen loss in tilled soil with legume but reduce nitrogen loss in non-tilled soil without legume. Soil Biology and Biochemistry 60: 105-112.

Toyota, A., Kaneko, N. (2012) Faunal stage-dependent altering of soil nitrogen availability in a temperate forest. Pedobiologia 55: 129-135.

Toyota, A., Tayasu, I., Fujimaki, R., Kaneko, N. Uchida, M., Shibata, Y., Hiura, T. (2010) Effects of vegetation switch and subsequent change in soil invertebrate composition of soil carbon accumulation patterns, revealed by radiocarbon concentrations. Radiocarbon 52: 1471-1486.

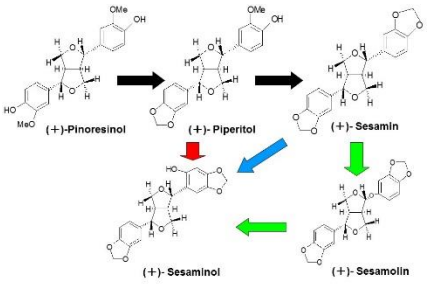
Research Area: Biological Molecular Chemistry
Research Specialization: Forest Biomass Chemistry
Name: KATAYAMA, Takeshi

Keywords: Wood, Lignan, Suberin, Bioactivity, Organic chemistry

Recent Research

1. Stereochemistry and Biosynthesis of Lignans

Lignans and neoolignans are dimers of phenylpropanes and generally have optical activity. They are present in the heartwood, bark, roots, leaves, and seeds of higher plants. They have various bioactivities and are attracting attention as medicines and health foods. We study the stereochemistry and biosynthesis of neolignans of *Eucommia ulmoides* and *Saururus chinensis* and functional lignans of sesame seeds (right figure).



Proposed biosynthetic pathway of sesaminol

2. Chemistry of Suberin in Outer Bark

Suberin is the main component of the cork tissue in outer bark (right picture) and of the wound-healing layers of potato tubers. It contributes to their functions (prevention of evaporation of water, protection against injury and pathogens, etc.). Its chemical structure is a complex three-dimensional heteropolymer composed of an aliphatic domain and an aromatic domain. The latter structure is much more unclear than that of the former, especially the structure of the outer bark is poorly studied. We focus on the fact that the suberin aromatic domain has a ferulic acid ester structure, unlike lignin.

3. Bioactive Components from Tropical Forest

A wide variety of tropical trees contain a wide variety of extractives. From these, we are exploring ingredients that have biological activities such as antioxidant and antifungal. Antioxidant lignans were obtained from seeds of Jatropha (right picture), a plant for biodiesel fuel.

4. Biomass Utilization of Indonesian Fast-growing Trees

In Southeast Asia, fast-growing trees such as falcata (right picture), eucalyptus, acacia, etc. are planted and supplied to the production of wood-based materials and paper. Using falcata waste wood, we are studying liquefaction and subsequent plasticisation, and pretreatment for bioethanol / biobutanol production.

Publications

・Syahidah, Katayama T., Suzuki, T., Asada, Y., Ohtani, Y., and Ohmura, W.: Antitermite and antifungal activities of *Vitex cofassus* heartwood. *Journal of the Forest Biomass Utilization Society*, **10** (2), 55-61, 2015.

・Andrianto, D., Katayama, T., and Suzuki, T.: Screening of Antioxidant and Antihyperlipidemic Potencies of Indonesian Underutilized Fruits. *Journal of the Forest Biomass Utilization Society*, **10** (1), 19-25, 2015.

・Lourith, N. Katayama T., Suzuki, T.: Biosynthesis of a syringyl 8-*O*-4' neolignan in *Eucommia ulmoides*: formation of syringylglycerol-8-*O*-4'-(sinapyl alcohol) ether from sinapyl alcohol. *Journal of Wood Science* **51**, 379-386.

Research Area: Bioresource & Functional Chemistry
Research Specialization: Plant Biochemistry
Name: KATO Hisashi

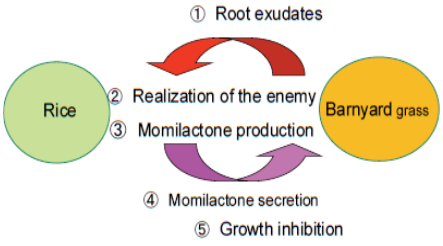
Keywords：**Allelopathy**，**Allelochemical, Tropical and subtropical plants**

Research topics: Allelopathy

The negative impacts of commercial herbicide use on the environment make it desirable to diversify weed management options. Many investigations have been attempted to exploit allelopathy of plants for weed control purposes in a variety of agricultural settings, since allelopathy is regarded as the direct influence of an organic chemical released from one living plant on the growth and development of other plants.

We have been extensively studied with respect to plant allelopathy as part of a strategy for sustainable weed management. We have already found and isolated several allelopathic substances from various plant sources and determined their chemical structures. We also try to understand the mode of action of the allelopathic substances for their biological activities by biochemical techniques such as protein, enzyme and gene levels.

We isolated new allelopathic substances



The chemical-cross talk between rice and barnyard grass

One of our students got the best oral presentation award on International Conference.

Publications

- Kato-Noguchi, H., Nakamura, K., Ohno, O., Suenaga, K., and Okuda, N.: Asparagus decline: autotoxicity and autotoxic compounds in asparagus rhizomes. Journal of Plant Physiology 213: 23–29 (2017).
- Kato-Noguchi, H.: Allelopathic chemical interaction of bryophytes with vascular plants. Mini-Reviews in Organic Chemistry 13: 422 - 429 (2016).
- Kato-Noguchi, H., Saito, Y., Ohno, O. and Suenaga, K.: A phytotoxic active substance in the decomposing litter of the fern *Gleichenia japonica*. Journal of Plant Physiology 176: 55-60 (2015).
- Kato-Noguchi, H., Salam, M.A., Ohno, O. and Suenaga, K.: Nimbolide B and nimbic acid B, phytotoxic substances in neem leaves with allelopathic activity. Molecules 19: 6929-6940 (2014).
- Kato-Noguchi, H., Ai Kobayashi, A., Ohno, O., Kimura, F., Fujii, Y. and Suenaga, K.: Phytotoxic substances with allelopathic activity may be central to the strong invasive potential of *Brachiaria brizantha*. Journal of Plant Physiology 171: 525-530 (2014).
- Kato-Noguchi, H. and Peters, R.J.: The role of momilactones in rice allelopathy. Journal of Chemical Ecology 39:175-185 (2013).

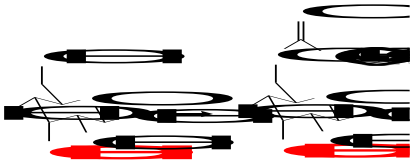
Research Area: Biological Molecular Science
Research Specialization: Synthetic Organic Chemistry
Name: KAWANAMI, Yasuhiro

Keywords: rare sugar, biological activity, asymmetric catalyst, aplysiatoxin, anti-cancer

Recent Research

1. Synthesis and Biological Evaluation of Rare Sugar Derivatives

Rare sugar is a monosaccharide that exists only in trace amounts in nature and has been shown to have various biological activities by our research on rare sugars. In order to further improve the biological activity of D-allose, which is an epimer at the C-3 position of D-glucose, we have synthesized D-allose fatty acid esters having a hydrophobic linear alkyl group from hydrophilic D-allose and are studying on structure-activity relationship of their plant growth inhibitory activity and cancer cell proliferation inhibitory activity.



2. Synthesis of optically active alcohols using asymmetric catalyst derived from amino acid

So far we have synthesized a natural amino acid derivative and developed an asymmetric borane reduction reaction of ketone using them as an asymmetric catalyst and demonstrated that the reaction proceeds with high stereoselectivity in asymmetric reduction of many aromatic ketones. At present, we are working on asymmetric reduction of trifluoromethyl ketone with low stereoselectivity due to high reactivity.

3. Function-Oriented Synthesis of Aplysiatoxin Simplified Analogs

Marine natural products, aplysiatoxin has tumor-promoting activity and cancer cell proliferation inhibitory activity. To develop novel anti-cancer agents with reduced side effects, we designed simplified analogs that eliminate tumor-promoting activity and evaluate their binding ability with kinase C playing an important role in intracellular signal transduction.

Publications

Synthese and biological activities of deoxy-D-alloses fatty acid ester analogs, *Biosci. Biotechnol. Biochem*., **88** (4), 676-681, 2016, Chowdhury, M. T. I., Naito, M., Yanagita, R. C., Kawanami, Y.

Binding mode prediction of aplysiatoxin, a potent agonist of protein kinase C, through molecular simulation and structure-activity study on simplified analogs of the receptor-recognition domain, *Bioorg. Med. Chem*., **24**, 4218-4227, 2016, Ashida, Y., Yanagita, R. C., Takahashi, C., Kawanami, Y., Irie, K.

Effect of BF_3 on the enantioselective reduction of trifluoromethyl ketones using a chiral lactam alcohol with borane, *Terahedron: Asymmetry*, **26**, 333-337, 2015, Harauchi, Y., Takakura, C., Furumoto, T., Yanagita, R. C., Kawanami, Y.

Anti-proliferative Activity of 6-*O*-Acyl-D-Allose against the Human Leukemia MOLT-4F Cell Line, *Biosci. Biotechnol. Biochem*., **78** (2), 190-194, 2014, Yanagita, R. C., Kobayashi, K., Ogawa, C., Ashida, Y., Kawanami, Y.

.

Research Area: **Biological Molecular Chemistry**
Research Specialization: **Bioactive Natural Products Chemistry**
Name: **SATO, Masashi**

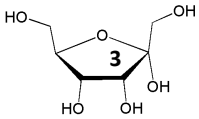
Keywords: Biologically active substance, *C. elegans*, Rare sugar, Anti-aging

Recent Research

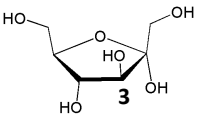
1. Exploration of anti-aging rare sugars

Restriction of calorie intake is known to prolong the life span of various experimental animals. Even in humans, calorie restriction retards the onset of age-related diseases such as diabetes and cancer, and as a result it is thought to prolong life span. We thought that rare sugars having a metabolic suppression effect would make the body calorie restricted and prolong the life of the animal. We conducted the research using the nematode *Caenorhabditis elegans*, a model animal of aging research, and have reported that the rare sugar D-allulose (a stereoisomer of D-fructose) extended the lifespan of *C. elegans*. Currently, we are working on searching for novel anti-aging substances from over 50 kinds of rare sugars and their derivatives, and are developing screening methods to find active substances conveniently and quickly.

C. elegans



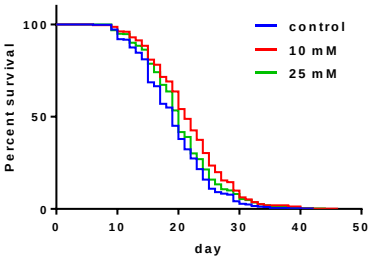
D-Allulose



D-Fructose

2. Mechanism of the anti-aging effect of rare sugars

We are working on elucidating the mechanism of action of rare sugar anti-aging effect by biochemical, molecular biological techniques, and bio-organic chemical approaches such as derivatives synthesis.



Lifespan extending effect of D-allulose

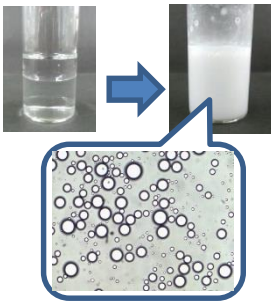
- Sato, M. et al.: Potential anthelmintic: D-psicose inhibits motility, growth and reproductive maturity of L1 larvae of *Caenorhabditis elegans*. J. Nat. Med.,62, 244-246, (2008).
- Sato, M. et al.: D-Ribose competitively reverses inhibition by D-psicose of Larval growth *in Caenorhabditis elegans*. Biological and Pharmaceutical Bulletin 32, 950-952 (2009) .
- Sato, M., et al.: Structural characteristics for superoxide anion radical scavenging and productive activities of green tea polyphenols including proanthocyanidin dimers. Chemical and Pharmaceutical Bulletin 58, 98-102 (2010).
- Sakoguchi, H. et al.: Growth inhibitory effect of D-arabinose against the nematode *Caenorhabditis elegans*: Discovery of a novel bioactive monosaccharide, Bioorg. Med. Chem. Lett., 26 726-729 (2016).
- Sakoguchi, H. et al.: Screening of biologically active monosaccharides: growth inhibitory effects of D-allose, D-talose, and L-idose against the nematode *Caenorhabditis elegans*, Biosci. Biotechnol. Biochem., 80 1058-1061 (2016).

Research Area: Biological Molecular Chemistry
Research Speciality: Biophysical Chemistry & Colloid Science
Name: FUKADA, Kazuhiro

Key words : surfactant, emulsion, bio-colloids, phase transition, rare sugar

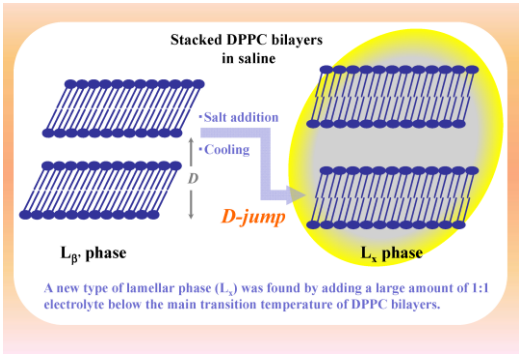
Recent Research

1. Protein-based O/W emulsions



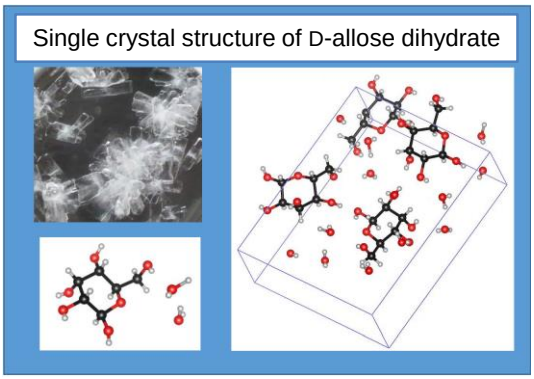
The oil-in-water (O/W) emulsions are aqueous liquids containing dispersed small oil droplets (usually < 10 μm diameter) . A large variety of industrial products such as processed-foods, medicines, pesticides, and cosmetics are produced as O/W emulsions. To prepare fairly stable emulsions, it is crucial to add some amphiphilic material as an emulsifier. We are studying on emulsifying properties of proteins (whey or egg white proteins, casein, and so on) to understand formation and stabilization mechanisms of small oil droplets in protein solutions by the emulsification processes.

2. Molecular assemblies of aqueous amphiphiles



When amphiphilic materials such as surfactants or phospholipids are mixed with water, they spontaneously form molecular assemblies, i.e., micelles or multi-lamellar vesicles, both of which are classified as associate colloidal system. In our laboratory, physico-chemical aspects on these colloids are studied focusing on the geometry of the molecular assemblies and effects of temperature and additives (salts, alcohols, and sugars) for the formation of assemblies.

3. Physico-chemical properties of rare sugars



Rare sugars are monosaccharides rarely existing in nature. Some of rare sugars, for example D-allulose, are recently found to have biological activities with benefit, and broad range of studies including molecular structure and rheological, spectroscopic, and thermodynamic properties in solution have been in progress. We are studying on basic phsico-chemical properties of rare hexoses to understand why living organisms did not select rare hexoses, but D-glucose and D-fructose, in their metabolisms.

Click here for more information

Publications

- A. Yoshihara, M. Sato, K. Fukada. Evaluation of the Equilibrium Content of Tautomers of Deoxy-ketohexoses and their Molar Absorption Coefficient of the Carbonyl Group in Aqueous Solution. *Chem. Lett.*, **45**, 113-115 (2016).
- T. Kozakai, K. Fukada, R. Kuwatori, T. Ishii, T. Senoo, K. Izumori. Aqueous Phase Behavior of the Rare Monosaccharide D-Allose and X-ray Crystallographic Analysis of D-Allose Dihydrate. *Bull. Chem. Soc. Jpn.*, **88**, 465-470 (2015).
- K. Fukada. Effects of Addition of Amphiphilic Molecules on the Dispersion Stability of Colloidal Systems. *Oleoscience*, **16**, 51-56 (2016). (in Japanese)
- N. Cheetangdee, K. Fukada, Emulsifying activity of bovine β-lactoglobulin conjugated with hexoses through the Maillard reaction. *Colloids Surfaces, A*, **450**, 148-155 (2014).

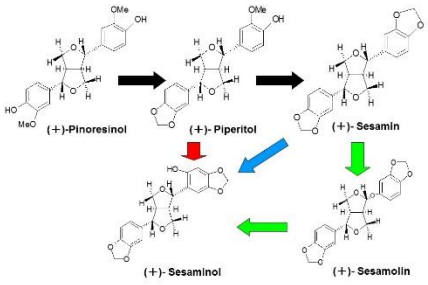
Research Area: Biological Molecular Chemistry
Research Specialization: Biomass Chemistry
Name: SUZUKI, Toshisada

Keywords：**Wood, Extractives, Bioactive substances, Biomass, Chemistry**

Resent research

1. Stereochemistry and Biosynthesis of lignans

Lignan exists to conifer and broadleaf tree heartwoods. It has the C6-C3-C3-C6 frame which consist of two phenyl propane unit (C6-C3) bounds. They are often exist as the glucoside in plants and shows optical activities. In the medical field, some of them are paid attention as bioactive substances. We investigate stereochemistry and biosynthesis of sesamin in sesame seeds, and lignans contained in *Eucommia ulmoides* and *Saururus chinensis.*



Proposed biosynthetic pathway of sesaminol

2. Chemistry of bark compounds

Suberin is one of the main components in outer bark of woody plants, wound surface of higher plants and periderm of underground organs. The plant biopolymer provides resistance against water loss, and is proposed to be a defensive barrier against invasion by bacteria, fungi and insect. The structure of suberin is expected to be composed of an aliphatic domain and an aromatic domain. While the structure and composition of the aliphatic domain are well investigated, those of the aromatic domain are unclear. We investigate the chemical structure and biosynthesis of the aromatic domain of suberin in outer bark of woody plants.

3. Bioactive substances of tropical trees

In tropical and subtropical regions, wide variety of plants are valuable genetic resources to provide bioactive constituents. Our current studies on isolation and identification of extractives of some Indonesian trees and their biological activity have been conducted in collaboration with some Indonesian researchers.

4. Fast-growing trees in Indonesia

In Indonesia, fast-growing trees such as falcata, acacia and eucalyptus have been planted for production of wood-based materials, pulp and paper. We investigate on effective utilization of waste wood and bark of the fast-growing trees.

Publications

Suzuki, *et al.*: Antioxidative catechol lignans/neolignans isolated from defatted kernel of *Jatropha curcas*. *Journal of Wood Science* 62, 339-348 (2016)

Suzuki, *et al.*: Extractives from Spanish Cherry and their Antioxidant Activity. *Journal of the Forest Biomass Utilization Society* 9, 57-60 (2014)

Suzuki, *et al.*: Furanoditerpenes from *Arcangelisia flava* (L.) Merr. and their antifungal activity. *Phytochemistry Letters* 4, 333-336 (2011)

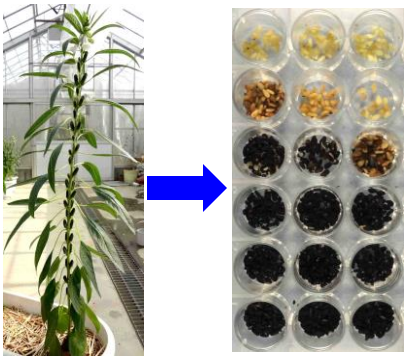
Research Area: Biological Molecular Chemistry
Research Specialization: Functional Phytochemistry
Name: FURUMOTO, Toshio

Key words: natural product chemistry, plant, chemical structure, biosynthesis, bioactivity

- ## Recent research

- ## 1. Secondary metabolites produced by plants

- Plants possess the ability to produce a variety of secondary metabolites (natural products). Our laboratory has carried out the isolation, structure determination, quantitative analysis, research for biosynthetic pathway and production mechanism, etc., about several plat secondary metabolites.
- For example, sesame seeds have been considered a valuable health food, and it is assumed that black seeds are more effective as health food than white seeds in Asia. Assay-guided fractionation of the extract from black seeds led to the isolation of a characteristic antioxidant that had a potent radical scavenging activity. Quinones are characterized by two carbonyl groups on a fully unsaturated ring and have various biological activities and wide utility. We isolated and elucidated the structures of many naphthoquinone and anthraquinone derivatives in *Sesamum indicum* roots and hairy roots. Moreover, the biosynthetic relationship among these quinone derivatives is under investigation.



- ## 2. Plant growth regulators in rhizoshere

- Plants produce and accumulate many organic compound in the roots, and the substances secreted or released from the roots affect other living organisms. We recently isolated a novel germination stimulant for the seeds of root parasitic weeds from sunflower root exudates.

Publications

• Furumoto, T. et al. (2003). Anthrasesamones from roots of *Sesamum indicum*. Phytochemistry 64: 863-866.

• Furumoto, T. et al. (2011). Biosynthetic origin of 2-geranyl-1,4-naphthoquinone and its related anthraquinone in a *Sesamum indicum* hairy root culture. Phytochemistry 72: 871-874.

• Furumoto, T. et al. (2012). Effect of chloride ions on anthrasesamone C production in a *Sesamum indicum* hairy root culture and identification of the precursor for its abiotic formation. Biosci. Biotechnol. Biochem. 76: 305-308.

• Furumoto, T. et al. (2016). Identification of a characteristic antioxidant, anthrasesamone F, in black sesame seeds and its accumulation at different seed developmental stages. Biosci. Biotechnol. Biochem. 80: 350-355.

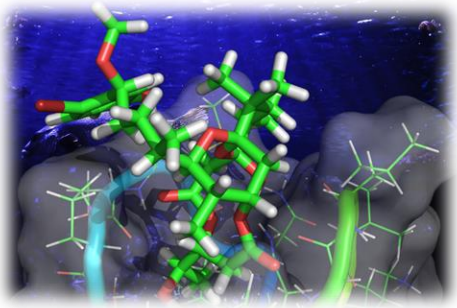
• Ueno, K. et al. (2014). Heliolactone, a non-sesquiterpene lactone germination stimulant for root parasitic weeds from sunflower. Phytochemistry 108: 122-128.

Research Area: Biological Molecular Chemistry
Research Specialization: Chemical Biology
Name: YANAGITA, Ryo C.

Keywords : Natural product, tumor promoter, analog synthesis

Recent Research

1. Development of simplified analogs of naturally-occurring tumor promoters



Tumor promoters are compounds which enhance tumorigenesis in cells initiated by a carcinogen. Recently, design and synthesis of simplified analogs of naturally-occurring tumor promoters with desirable therapeutic effects including anticancer effect have been reported.

We are currently studying on the development of simplified analogs of aplysiatoxin, a polyacetate isolated from sea hare, and thapsigargin, a sesquiterpene lactone isolated from Apiaceae plant, being synthetically accessible and having less side effect.

2. Screening of new protein kinase C ligands with anti-proliferative activity

Protein kinase C (PKC) is a family of serine/threonine kinase that involves in many cellular function, and are attracted as potential therapeutic target for the treatment of cancer, Alzheimer's disease, and AIDS.

We are searching for new PKC ligands from plant sources by an assay using synthetic PKC C1 peptides.

3. Development of biologically active derivatives of naturally-rare monosaccharide

Several of naturally-occurring monosaccharides are found to exhibit biological activities including anti-cancer activity. We currently focus our attention on the development of rare monosaccharide derivatives with "unnatural" moiety to improve their cell permeability and biological activities.

Publications

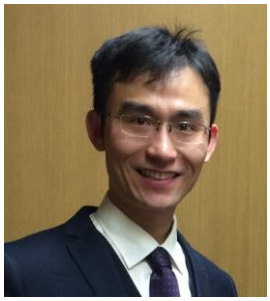
Ueno, S., *et al.* Identification and Biological Activities of Bryostatins from Japanese Bryozoan. *Biosci. Biotechnol. Biochem.* **2012**, *76*, 1041–1043.

Yanagita, R. C., *et al.* Effects of the methoxy group in the side chain of debromoaplysiatoxin on its tumor-promoting and anti-proliferative activities. *Bioorg. Med. Chem. Lett.* **2013**, *23*, 4319–4323.

Yanagita, R. C., *et al.* Anti-proliferative activity of 6-*O*-acyl-D-allose against the human leukemia MOLT-4F cell line. *Biosci. Biotechnol. Biochem.* **2014**, 78, 190–194.

Ashida, Y., *et al*. Binding mode prediction of aplysiatoxin, a potent agonist of protein kinase C, through molecular simulation and structure–activity study on simplified analogs of the receptor-recognition domain. *Bioorg. Med. Chem.* **2016**, *24*, 4218–4227.

Research Area: Biological Molecular Chemistry
Research Specialization: Rare sugar organic chemistry
Name: KONG, Lingbing

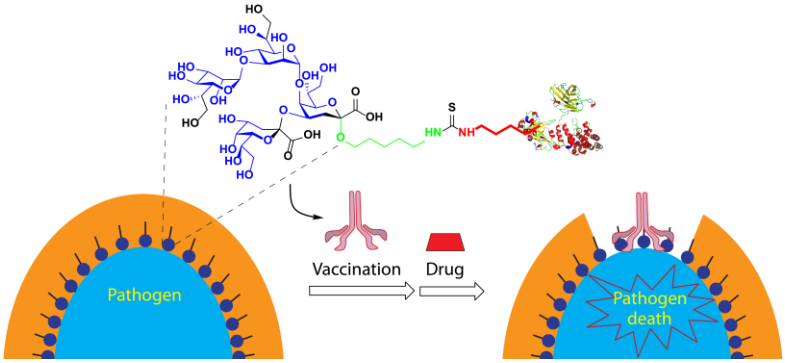


Keywords：sugars, rare sugars, organic chemistry, sugar transporters

Recent Research

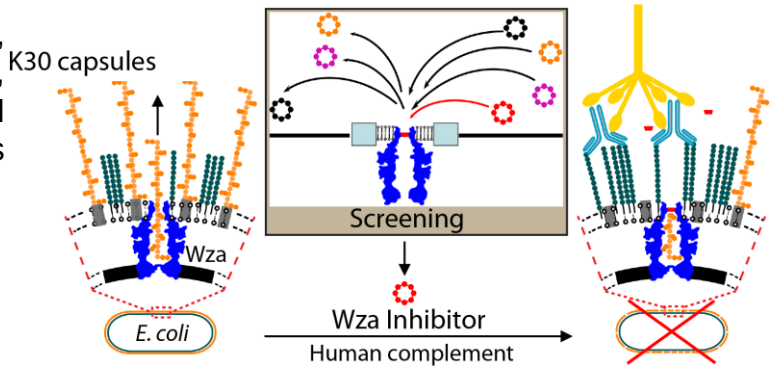
1. Rare sugar production

We use organic chemistry to strengthen rare sugar production with a combinational technology of sugar enzymology and sugar chemistry



2. Functional analysis of sugar transporters

We analyse sugar transporters, especially those related to rare sugars, with single-molecule electrical channel recording to allow functional analysis and development of novel therapeutics.



Publications

・A monodisperse transmembrane α-helical peptide barrel, *Nature Chemistry*, 9, 411-419, 2017, Kozhinjampara R. Mahendran, Ai Niitsu, **Lingbing Kong**, Andrew R. Thomson, Richard B. Sessions, Derek N. Woolfson and Hagan Bayley

・Chemical polyglycosylation and nanolitre detection system enables single-molecule recapitulation of bacterial sugar export, *Nature Chemistry*, 8, 461-469, 2016, **Lingbing Kong**, Andrew Almond, Hagan Bayley and Benjamin G. Davis

・An antibacterial vaccination strategy based on a glycoconjugate containing the core lipopolysacchride tetrasaccharide Hep_2Kdo_2, *Nature Chemistry*, 8, 242-249, 2016, **Lingbing Kong**, Balakumar Vijayakrishnan, Michael Kowarik, Jin Park, Alexandra N. Zakharova, Larissa Neiwert, Amirreza Faridmoayer and Benjamin G. Davis

・Single-molecule interrogation of a bacterial sugar transporter allows the discovery of an extracellular inhibitor, *Nature Chemistry*, 5, 651-659, 2013, **Lingbing Kong**, Leon Harrington, Qiuhong Li, Stephen Cheley, Benjamin G. Davis and Hagan Bayley.

Research Area: Plant Science
Research Specialization: Plant Pathology
Name: AKIMITSU, Kazuya

Keywords: Host-selective toxin, Rare sugar, Genome, Mitochondria, Citrus

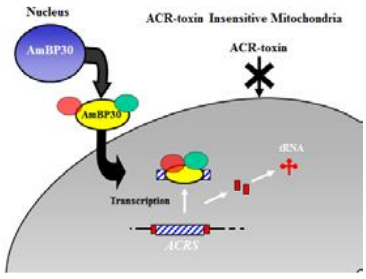
Recent Research

1. Biosynthesis gene cluster of Host-selective Toxin from *Alternaria* species

Host-selective toxins are second metabolic compounds with a low molecular weight, which are produced by several different pathotypes of *Alternaria* species. The host-range of toxin producer is equal to the host-selectivity of the toxin, and a loss of the toxin production leads a loss of pathogenicity. In our laboratory, we identified one dispensable chromosome carrying biosynthetic gene cluster for esters of 9,10-epoxy-8-hydroxy-9-methyl-decatrienoic acid (ACT-toxin) and another chromosome carrying that for polyketide (ACR-toxin). Target gene disruption and RNA silencing of the genes in the respective cluster caused a loss of the toxin production and pathogenicity, indicating the necessity of these genes in the toxin production as well as the pathogenicity.

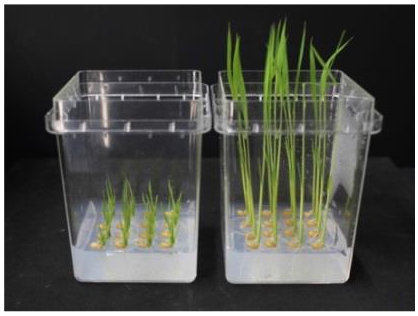
2. Mechanism for appearance of plant mitochondrial disease cause by disfunction in modification of internal region of tRNA-Ala

ACRS gene encoding ACR-toxin receptor protein is located in the internal region of tRNA-Ala in mitochondrial genome, and the transcript of the region is processed in the toxin-insensitive cultivars of citrus. We examine the processing protein complex of the receptor gene transcript, and qualify the mechanism of host selectivity from both pathogen and host sides.



3. Mechanism of rare sugar effects in plants

Rare sugars give effects on plants; such as a transient growth inhibition and induction of defense-related gene expression. The mechanism controlling these effects was identified and we are trying to use them for agricultural practices. *Itea* plant producing rare sugar is also examined on the processes of the sugar production as well as the evolutional role of rare sugar production.



HP http://www.ag.kagawa-u.ac.jp/plantpathology/index.html

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Endopolygalacturonase is essential for citrus black rot caused by *Alternaria citri* but not brown spot caused *by Alternaria alternata*(2001) A Isshiki, K Akimitsu, M Yamamoto, H Yamamoto, Molecular Plant-Microbe Interactions 14 : 749-757.

Host-selective toxins produced by the plant pathogenic fungus *Alternaria alternata* (2012) T Tsuge, Y Harimoto, K Akimitsu, K Ohtani, M Kodama, Y Akagi, M Egusa, …, FEMS Microbiology Reviews 37: 44-66.

Molecular, ecological and evolutionary approaches to understanding Alternaria diseases of citrus (2003) K Akimitsu, TL Peever, LW Timmer, Molecular Plant Pathology 4: 435-446.

Sensitivity to *Alternaria alternata* toxin in citrus because of altered mitochondrial RNA processing (2002) K Ohtani, H Yamamoto, K Akimitsu, Proceedings of the National Academy of Sciences 99: 2439-2444.

The rare sugar D-allose acts as a triggering molecule of rice defence via ROS generation (2013) A Kano, T Fukumoto, K Ohtani, A Yoshihara, T Ohara, S Tajima, K Izumori, . K Akimitsu, Journal of Experimental Botany 64: 4939-4951.

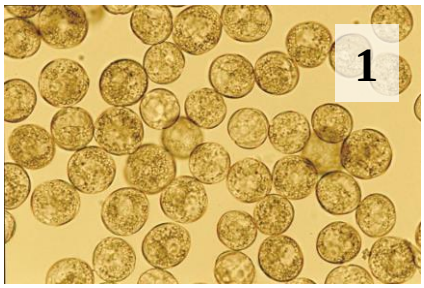
Research Area: Plant Science
Research Specialization: Plant Cellular and Developmental Biology
Name: KYO, Masaharu

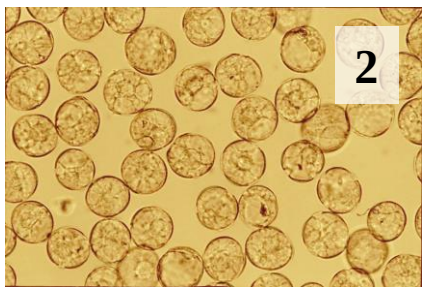
Keywords: immature pollen, cell culture, embryogenesis, totipotency

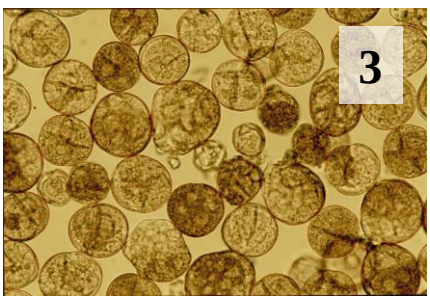
Recent Research

1. Pollen embryogenesis

Since the first observation in 1964, embryogenesis of immature pollen through anther culture is well known as an important means to producing haploid useful in a high-efficient breeding method. However, with the exception of a limited number of species, the frequency of the phenomenon is generally low and the breeding method is not popularized. To examine the process from immature pollen to totipotent embryogenic cells we developed a pollen culture system [1,5], where freshly isolated tobacco pollen grains at mid-bicellular stage (Panel1) dedifferentiate showing a specific aspect (Panel2) in 2 days under a starveling condition. Their totipotency could be verified through the subsequent culture (Panel3,A,B,C). Previously, we found various events highly associated with the dedifferentiation, for example, appearance of specific phosphorylated proteins [4], specific gene transcripts [3] and activation of specific promoters [2]. Recently, we revealed that the isolated pollen vegetative cells proceed to S phase within 24 h as the first step towards embryogenesis, deviating from G1 arrest bound to maturation [1]. We hope these observations will be integrated to understand the induction mechanism of androgenesis.

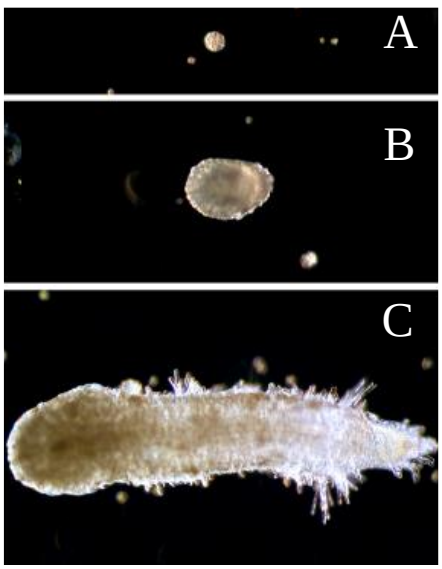






2. Regeneration-promoting genes

It is a key subject in plant biotechnology to find “regeneration-promoting genes” because such genes are useful for producing transgenic plants more efficiently, especially in crops recalcitrant for traditional regeneration protocols in vitro using cytokinin. Recently, we found co-expression of specific two genes promotes the regeneration competency in tobacco leaf segment culture without cytokinin. We are working on transformation of some recalcitrant crops using an expression vector harboring the two genes.



References

[1] Kyo, et al. (2014) Timing of the G1/S transition in tobacco pollen vegetative cells as a primary step towards androgenesis in vitro. Plant Cell Reports 33:1595-1606

[2] Yamaji and Kyo (2006) Two promoters conferring active gene expression in vegetative nuclei of tobacco immature pollen undergoing embryogenic dedifferentiation. Plant Cell Reports 25:749-757

[3] Kyo, et al.(2003) Cloning and characterization of cDNAs associated with embryogenic dedifferentiation of tobacco immature pollen grains. Plant Science 164:1057-1066

[4] Kyo and Harada (1990) Specific phosphoproteins in the initial period of tobacco pollen embryogenesis. Planta :182:53-63

[5] Kyo and Harada (1986) Control of the developmental pathway of tobacco pollen in vitro. Planta 168: 427-432

Research Area: **Plant Science**
Research Specialization: **Molecular Plant Nutrition**
Name: **NOMURA, Mika**

Keywords : symbiosis, legume, nodule, nitrogen fixation

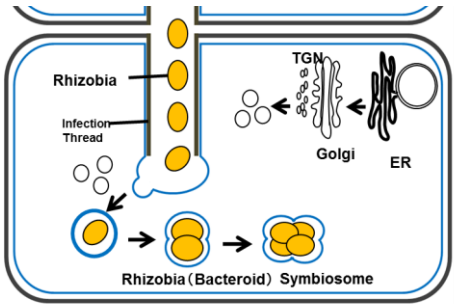
Recent Research

1. Membrane fusion by SNARE in *Lotus japonicus* nodule

Legume produces nodules when rhizobia infect with root and fixes atmospheric nitrogen to produce ammonia. In the nodule these rhizobia are enclosed by plant derived organelles, symbiosome, and differentiate into the bacteroid.

We are studying the SNARE protein which has function for the nodule formation and could find one of the SNAREs which has important role to produce symbiosome in Lotus nodules. We are now analyzing for the SNARE complex proteins for the symbiosome membrane.

Lotus japonicus (Left) and nodule (Right)



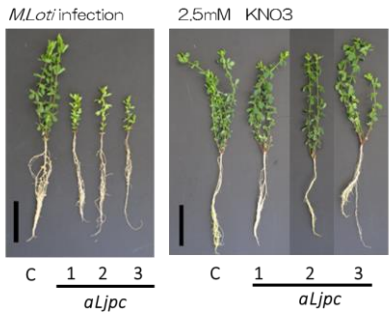
Rhizobia is enclosed by symbiosome membrane derived from plant

2. Transcription factors for the nitrogen fixation

When rhizobia fix nitrogen in the nodule, legume has to provide carbon source. We have previously found that PEPC which expresses in the nodule for the production of respiratory substrate, malate (Nomura et al, PCP 2006). However, there is no report of the transcription factors for the regulation of carbon metabolism in the nodule. We are now analyzing for the transcription factors for the regulation of nitrogen fixation.

3. Analysis of ferritin for the nodule senescence

We have performed the transcriptome analysis for the nodule senescence and found that an iron accumulating protein, ferritin, accumulates in the aging nodule (Cungopast et al., Plant Biotech, 2014, J Plant Physiol, 2017). We speculates these iron would be transported to shoot. We are analyzing iron transporter in the nodule.



Transgenic plants by suppression of PEPC genes.
Left: Plants were grown by the infection of M. loti (Left) and by addition of KNO3 (Right). C: control, aLjpc: transgenic plants by suppression of nodule Pepc gene.

Click here for more information.

Publications

・Iron-induced nitric oxide leads to an increase in the expression of ferritin during the senescence of *Lotus japonicus* nodules, Chungopast, S., Duangkhet, M., Tajima, S., Ma,J.F., Nomura, M. J Plant Physiol. 208, 40-46 (2017)

・A MYB-related transcription factor affects nodule formation in *Lotus japonicus*, Supriadi, Duangkhet,M., Thepsukhon, A., Widyastuti, R., Santosa, D.A., Tajima, S., Nomura, M. Plant Biotech. 33, 187-194 (2016)

・Transcriptomic profiles of nodule senescence in *Lotus japonicus* and *Mesorhizobium loti* symbiosis, Chungopast, S., Hirakawa, H., Sato, S., Handa, Y., Saito, K., Kawaguchi, M., Tajima, S., Nomura, M. . Plant Biotech, 31, 345-349 (2014)

・Glutamine synthetase I-deficiency in *Mesorhizobium loti* differentially affects nodule development and activity in *Lotus japonicus*, Chungopast, S., Thapanapongworakul, P., Matsuura, H., Dao, T.V., Asahi, T., Tada, K., Tajima, S., and Nomura, M. J Plant Physiol., 171, 104-108 (2014)

Research Area: Plant Science

Research Specialization: Plant Stress Responses

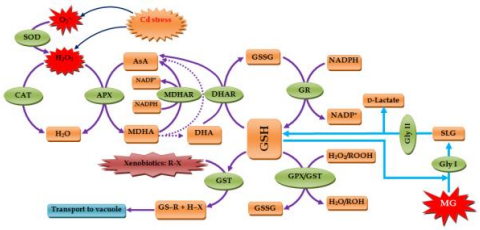
Name: FUJITA, Masayuki

Keywords: environmental stress, active oxygene, methylglyoxal, phytoprotectant

Recent Research

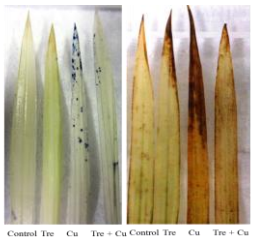
1. Plant Stress Tolerance Based on Network of Antioxidant and Methylglyoxal Detoxification Systems

Various endogeneous toxic substances significantly occur in plant body under stressful conditions. Reactive oxygen species (ROX) and methylglyoxal are represented among them and have been demonstrated as the main causes of cellular damage and stunt in growth. On the other hand, plants have genetically improved detoxification systems against them. Their substantial ability reflects on their stress tolerance. We study on the relation between the ROX and methylglyoxal detoxification systems consisting of glutathione and ascorbic acid etc. and stress tolerance.



2. Plant Stress Responses to Heavy Metals, Salt, Drought, Temperature Stresses

In a changing world plants experience various kinds of environmental stresses (salinity, drought, heat, cold, flooding, heavy metals, ozone, UV radiation, etc.) which affect plant growth, yield and productivity that challenges the food security of future growing population all over the world. We study the plant responses to abiotic stresses phenotypically, physiologically and biochemically.



3. Phytoprotectants; Reinforcement Factors in Plant Tolerance against Abiotic Stresses

We investigate the candidates as phytoprotectants against stressful conditions. Compatible solutes, glycinebetaine, proline, trehalose; Antioxidants, ascorbic acid, glutathione; Plant hormone and other signal molecules, salicylic acid, jasmonic acid, NO, H_2O_2; Polyamines, spermine, spermidine, putrecine; Metal and elements, selenium, Si, Ca, H_2S; Isoprene; (Cross talk protection), cold-shock, heat-shock.

Control Na1 Na2 Se Se+Na1 Se+Na2

Publications

Hasanuzzaman, M. and Fujita, M. (2012) Crop Phytotechnologies: Remediation of Environmental Contaminants. In: Heavy metals in the environment: Current status, toxic effects on plants and phytoremediation, 7-74, CRC Press, Taylor & Francis Group, Oxford, UK,

Hasanuzzaman, M. and Fujita, M. (2013) Cadmium –Charasteristics, Sources of Exposure, Health and Environmental Effects, 1-369, Nova Publishers, New York.

Mostofa, M. G., *et al.* (2014) Trehalose pretreatment induces salt tolerance in rice (Oryza sativa L.) seedlings: oxidative damage and co-induction of antioxidant defense and glyoxalase systems, *Protoplasma*, DOI: 10.1007/s00709-014-0691-3.

Mostofa, M. G., *et al.* Interactive effects of nitric oxide and glutathione in mitigating copper toxicity of rice (Oryza sativa L.) seedlings, *Plant Signaling & Behavior*, in press.

Research Area: Plant Science
Research Specialization: Plant Functional Genomics and Plant immunity
Name: ICHIMURA, Kazuya

Keywords: Plant immunity, Environmental stress, signal transduction, *Ralstonia solanacearum*, effector, *Arabidopsis thaliana*, *Nicotiana benthamiana*

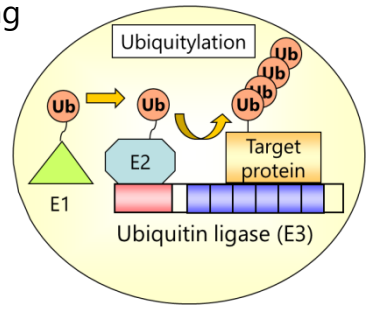
1. Plant immunity signaling mediated by MAP kinase pathways

1.1 Autoimmunity phenotype of MEKK1 → MKK1 / MKK2 → MPK4 pathway mutants.

Arabidopsis MEKK1, a MAPKKK, comprises specific MAPK pathway with downstream MKK1/MKK2 (MAPKKs) and MPK4 (MAPK). This pathway is activated in the downstream of PRRs and proposed to be involved in a part of PTI signaling. In contrast, loss-of-function of the pathway results in severe dwarfism and constitutive ETI responses such as cell death and ROS accumulation. To elucidate complex mechanism underlying the phenotype, we use genetic and molecular biological approaches using *Arabidopsis thaliana* genome resources.

1.2 Ubiquitin ligase involved in regulation of MEKK1 → MKK1/MKK2 → MPK4 pathway

We identified a ubiquitin E3 ligase as a MEKK1-binding protein by yeast two-hybrid screening. Molecular biological analyses are in progress to clarify function of E3 ligase in immunity signaling through the MEKK1→ MKK1/MKK2 → MPK4 pathway



1.3 Identification of novel pathway related to an innate immunity singling in *Arabidopsis*

According to the annotation, *Arabidopsis* genome contains over 80 MAPKKKs, 10 MAPKKs, and 20 MAPKs. This suggests that the MAP kinase pathways have to be composed of numerous combinations of protein kinases and that transduce various extracellular stimuli to activate physiological responses. We performed binding assay for the *Arabidopsis* MAP kinase pathway components towards identification of a novel signaling pathway, and we analyze possible pathway to find out its biological role.

2. *Ralstonia* functional effectomics towards identifying novel immunity signaling in plants

Ralstonia solanacearum is the causative agent of bacterial wilt disease against more than 200 of plant species mainly *Solanaceae*. The broad host range of bacterial wilt is thought to be conferred by relatively large effector repertoire (> 70) to other pathogenic bacteria. Using the advantage of *Ralstonia* effector repertoire, we performed functional screening to find effectors suppress defense responses. With these effectors, we aim to identify a novel immunity signaling components in plants.

Publications

Ichimura, K. *et al*., SGT1 contributes to maintaining protein levels of MEK2^{DD} to facilitate hypersensitive response-like cell death in *Nicotiana benthamiana*, *Physiological and Molecular Plant Pathology*, 94, 47-52, 2016.

Yamada, K. *et al*., The *Arabidopsis* CERK1-associated kinase PBL27 connects chitin perception to MAPK activation, *EMBO Journal*, 35, 2468-2483, 2016.

Nakamura, S. *et al*., *Mitogen-Activated Protein Kinase Kinase 3* Regulates Seed Dormancy in Barley, *Current Biology*, 26, 775-781, 2016.

Stegmann, M. et al. (2012) The ubiquitin ligase PUB22 targets a subunit of the exocyst complex required for PAMP-triggered responses in *Arabidopsis*. *Plant Cell*, 24, 4703-4716.

Takahashi, F. et al. (2011) Calmodulin-dependent activation of MAP kinase for ROS homeostasis in *Arabidopsis*. *Molecular Cell*, 41, 649-660.

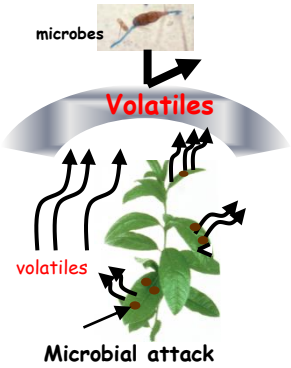
Research Area: **Plant Science**
Research Specialization: **Plant Pathology**
Name: **GOMI, Kenji**

Keywords: Jasmonate, Plant volatiles, Plant hormone, rice

Recent Research

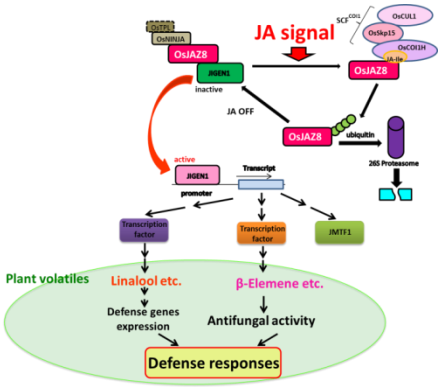
1. Role of plant volatiles in plant defense response

Terpenoids such as monoterpenes and sesquiterpenes are one of the most common volatiles emitted from plants in response to herbivory. Some terpenoids are emitted in response to treatment with abiotic or biotic elicitors and to fungal. However, there is a dearth of research about the role of individual volatiles in plant defense. We investigate roles of each volatile in plant defense response.



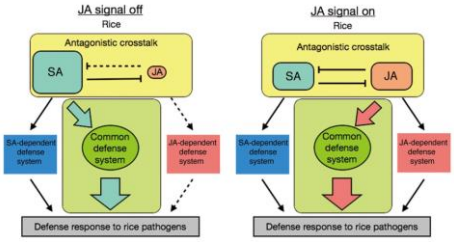
2. Mechanism of jasmonate siganlings in defense response

The plant hormone jasmonic acid (JA) or its derivative, an amino acid conjugate of JA, is a plant signaling compound involved in the regulation of plant defense and development. There are many studies about jasmonate signalings in dicot plants. However, there is a dearth of research about the role of jasmonte signalings in monocot plants including rice, which is one of the most important crops worldwide. We investigate mechanisms of jasmonate signalings in rice defense responses.



3. Crosstalk between plant hormones

Jasmonic acid (JA) and salicylic acid (SA) play important roles in plant defense systems. JA and SA signaling pathways interact antagonistically in dicotyledonous plants, but, the status of crosstalk between JA and SA signaling is unknown in monocots. We investigate relationship between JA and SA in rice defense responses.



Publications

- Overexpression of OsMYC2 results in the upregulation of early JA-responsive genes and bacterial blight resistance in rice. Uji et al., *Plant and Cell Physiology* 57, 1814-1827, 2016.
- Jasmonate-induction of the monoterpene linalool confers resistance to rice bacterial blight and its biosynthesis is regulated by JAZ protein in rice. Taniguchi et al., *Plant Cell Environment* 37: 451-461. 2014.
- Isolation of jasmonate-induced sesquiterpene synthase of rice: product of which has an antifungal activity against *Magnaporthe oryzae*. Taniguchi et al., *Journal of Plant Physiology* 171, 625-632. 2014.
- Jasmonic acid and salicylic acid activate a common defense system in rice. Daisuke Tamaoki, et al., *Plant Signaling Behavior* 8, e24260, 2013.
- Involvement of OsJAZ8 in jasmonate-induced resistance to bacterial blight in rice. Shoko Yamada, , et al., *Plant and Cell Physiology* 53, 2060-2072, 2012.

Research Area: Plant Science
Research Specialization: Molecular Breeding in Plant
Name: KONISHI-SUGITA Saeko

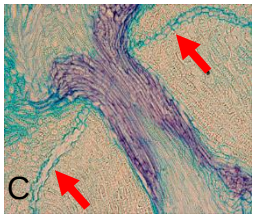
Keywords: rice, seed shattering, imaging, breeding

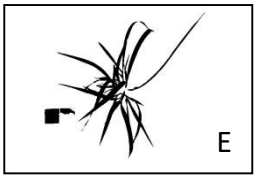
Recent Research

1. Analysis of molecular mechanism about abscission layer formation and degradation in seed shattering in rice

Seed shattering is a trait of seed shedding from panicles (Fig.A). It is an important trait as a breeding strategy by the spread of seeds in nature. On the other hand, when considered as crops, strong seed shattering leads to a reduction in crop yield. Therefore, it is considered to be one of important agricultural traits even today. Our laboratory has isolated seed shatteirng gene *qSH1* in rice and it is clear that it is essential for abscission layer formation (Fig.B,C) In addition, a candidate gene downstream of *qSH1* was found by performing a site-specific microarray analysis using the laser microdissection method. Furthermore, we are searching for new genes by analyzing mutant strains using gamma ray irradiation.

2. Characteristics extraction of leaves in rice using image analysis





In the early growth of plants, chemical energy obtained by photosynthesis is consumed to maintain life activities of plants by respiration and the like. The surplus is used for the formation and growth of new plants. Newly formed leaves will also photosynthesize and contribute to further individual growth. In this way, initial growth exhibits a complex positive feedback aspect. Therefore, slight differences in the natural environment during initial growth can lead to large differences in individual size. In our laboratory, we used a measurement system (Fig. D, E) for nondestructively monitoring plant growth (growth rate) of plants under natural environment. We are aiming at the production of high CO2-absorbing rice lines with rice as a crop material as an indicator of improvement of plant growth rate.

3. Selection of rice variety for rice flour and challenge to application

In recent years the price of wheat has soared, the use of rice as rice flour, improvement of food self-sufficiency rate, effect of eliminating cultivation abandonment area is beginning to be expected. However, since wheat flour and rice flour have various components such as amylose content and protein content, it is essential to develop and use varieties corresponding to each application. Therefore, selection and characterization of rice varieties suitable for foods using rice flour are being conducted.

Publications

Nao Tada, Katsuyuki Nii, Saeko Konishi-Sugita (2015) Mutant breeding of a Japanese traditional black rice cultivar ‘Yayoi Murasaki’ to improve seed shattering trait,The Nucleus, 58(3):217-223.

Konishi, S. *et al*. (2008) Inference of japonica rice domestication process from the distribution of six functional nucleotide polymorphisms of domestication-related genes in various landraces and modern cultivers. Plant & Cell Physiology, 49(9) 1283-1293.

Konishi, S. *et al*. (2006) An SNP caused loss of seed shattering during rice domestication. Science, 312, 1392-1396.

Research Area: Plant Science
Research Specialization: Somatic Cell Genetics
Name: IKEDA, Shigeru

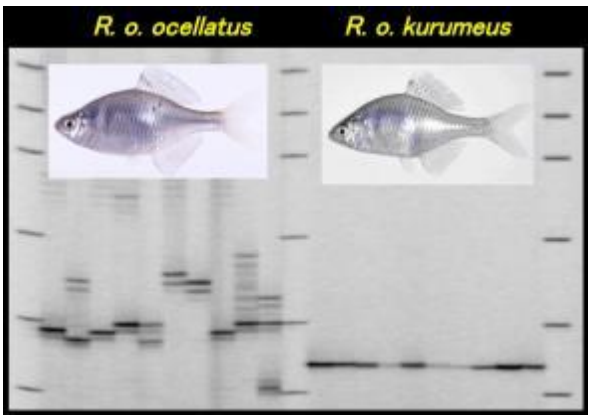
Keywords：DNA marker, endangered species, somatic cell mutation, DNA repair

Recent Research

1. Conservation Biology of Endangered Species

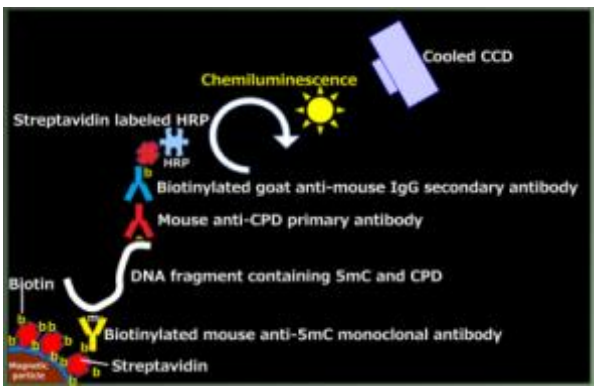
Nippon-baratanago, *Rhodeus ocellatus kurumeus,* is a small freshwater fish endemic to Honshu Island of Japan. It used to inhabit almost all over western Japan before the accidental introduction of an alien subspecies, *R. o. ocellatus*, in 1942. *R. o. kurumeus* has been an endangered species since mid-1990s. Protecting *R. o. kurumeus* requires protecting their habitats, one of which is eastern Kagawa, and routinely testing samples collected from the habitats for introgression.

From the viewpoint of conservation of genetic resources of *R. o. kurumeus*, I have been developing DNA markers for distinguishing two subspecies and evaluating the genetic variation within Kagawa population of *R. o. kurumeus*.



2. Somatic Cell Mutagenesis in Plants

In vitro culturing of plant cells induces somatic cell mutations at different levels. However, the mechanisms underpinning somatic cell mutagenesis remain to be uncovered. Rice suspension cell cultures are maintained here for a decade to be utilized for the research conducted to quantitate copy number variations of telomeres, microsatellites, and transposons and develop accurate and reproducible detection methods of modified nucleotides and sequence variations.



代表的な研究業績

・Inefficient repair of pyrimidine dimers in DNA fragments containing 5-methylcytosine, Program and Poster Abstracts Phytogene Symposium VIII, 20, 2016, **Ikeda S.**
・Developmen of a sensitive detection method for cyclobutane pyrimidine dimers and its applications, Program and Poster Abstracts Phytogene Symposium VII, 14, 2014, **Ikeda S**.
・Effects of anthocyanin and its precursors on photoreactivation of ultraviolet-B-induced cyclobutane pyrimidine dimers in purple rice, Program and Poster Abstracts Phytogene Symposium VI, 2013, **Ikeda S.**
・Isolation and characterization of new microsatellite markers for rose bitterlings, Molecular Ecology Resources 9, 1031, 2009, Shirai Y, **Ikeda S**, Tajima S.

Research Area: Plant Science
Research Field: Rare sugar molecular biology
Name: MOCHIZUKI, Susumu

Keywords: Rare sugars, Genetic Functions, Plant biology, Microbiology, Plant-Microbe interactions

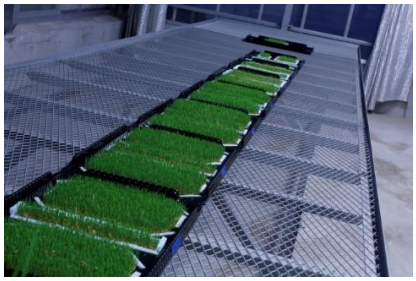
Recent Research

1. Rare sugar production

Several sugar converting enzymes were isolated at Kagawa University using the Izumoring strategy. These enzymes made it possible to produce many types of rare sugars, including D-allulose. Prompted by the growing industrial potential of rare sugars, the present study aims to select the best enzymes for production of rare sugars, and to improve their production efficiency by using genetic engineering methods.

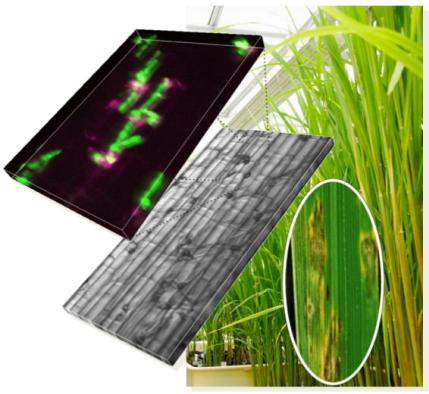
2. Functional mechanisms of rare sugars

These rare sugars can potentially be used for many applications, including in health food products, pharmaceutical products, and agricultural materials. However, the functional mechanisms of rare sugars have not yet been clarified. To gain a better understanding of how rare sugars act upon living cells, we are analyzing gene functions in sugar-treated plants and microbes.



3. Plant-microbe interaction

Microorganisms have the ability to produce these sugars, and plants are able to store them. Many primary and secondary metabolism-related genes function in both plants and microbes during their interaction. To understand sugar and sugar-related metabolisms in more detail, we are analyzing the functions of these genes during interactions between plants and plant pathogenic fungi (*Magnaporthe* and *Alternaria*).



Publications

- Nishimura, T., Mochizuki, S. *et al*. (2016) *Magnaporthe oryzae* Glycine-Rich Secretion Protein, Rbf1 Critically Participates in Pathogenicity through the Focal Formation of the Biotrophic Interfacial Complex, *PLOS Pathogens*, 12(10), e1005921.
- Mochizuki, S. *et al*. (2015) Live-cell imaging of rice cytological changes reveals the importance of host vacuole maintenance for biotrophic invasion by blast fungus, *Magnaporthe oryzae*, *MicrobiologyOpen*, 4(6), 952-966.
- Mochizuki, S. *et al*. (2014) Ubiquitin ligase EL5 maintains the viability of root meristems by influencing cytokinin-mediated nitrogen effects in rice, *Journal of Experimental Botany*, 65(9), 2307-2318.
- Kouzai, Y. *et al*. (2014) Targeted Gene Disruption of *OsCERK1* Reveals Its Indispensable Role in Chitin Perception and Involvement in the Peptidoglycan Response and Immunity in Rice, *Molecular Plant-Microbe Interactions*, 27(9), 975-982.
- Sakai, T., Mochizuki, S. *et al*. (2012) The WAVY GROWTH 3 E3 ligase family controls the gravitropic response in Arabidopsis roots, *The Plant Journal*, 70, 303-314.
- Mochizuki, S. *et al*. (2011) Localization of probe-accessible chitin and characterization of genes encoding chitin-binding domains during rice–*Magnaporthe oryzae* interactions, *Journal of General Plant Pathology*, 77, 163-173.

Research Area: Applied Life Science
Research Specialization: Applied Microbiology
Name: ASADA, Yasuhiko

Keywords:
Edible Mushroom、Health-promoting function、rare sugar、enzyme application

Recent Research

1. Development of novel resource-saving and environmentally friendly cultivation methods of edible mushrooms

The aim of this research is to develop novel resource-saving environmentally friendly cultivation methods of edible mushrooms.

1. Utilization of unutilized biomass resouces and agricultural wastes for the culture of edible mushrooms.
2. Development of hydropolonic culture method of edible mushrooms.

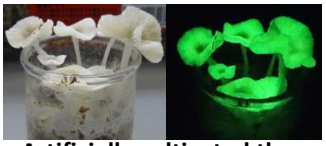
Cultivation of *Flammulina veltipes* and *Pleurotus osreatus* using the unutilized biomassresource,bamboo.

2. Development of cultivation methods for edible mushrooms having the enhanced health-promoting functions

Various mushrooms are known to have a variety of health-promoting functions (anti-tumor, anti-oxidative, anti-diabetic, immunostimulatory activities etc.). The aim of this study is to develop the cultivation methods for edible mushrooms having the enhanced health-promoting functions. Utilization of rare sugars (having health-promoting functions as well) to reach the above objective is in progress.

3. Analyses of the interesting and important characteristics of mushrooms

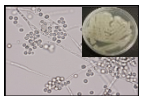
In my laboratory, we are in progress to study on the interesting and important characteristics of mushrooms and to develop their applications.



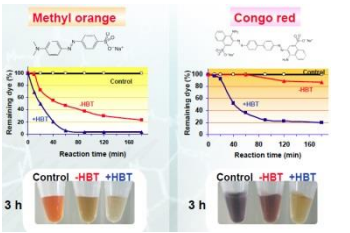
Artificially cultivated the luminous mushroom

4. Screening・analysis・application of useful enzymes produced by microbes

The aim of this study is to screen the microbes producing the useful enzymes. For example, we isolated a fungus form the soil producing a novel polyol oxidase which is very useful for the production of various rare sugars.



Penicllium sp. KU-1 strain isolated from the soil.
～This fungi produces the novel polyol oxidase which is very useful for the production of rare sugars ～



Decolorization of synthetic dyes by an enzyme produced by *Grifola frondosa* (Maitake)

Publications

Shompoosang, S. et al. (2016) Novel Process for Producing 6-Deoxy Monosaccharides from L-Fucose by Coupling and Sequential Enzymatic Method, Journal of Bioscience and Bioengineering, 121: 1-6.

Syahidah et al. (2015) Efficiency of *Sandoricum koetjape* extract against a subterranean termite, *Coptotermes formosanus* and wood rotting fungi, Journal of the Forest Biomass Utilization Society Japan, 10: 63-70.

Chairin, T. et al. (2014) Purification and characterization of the extracellular laccase produced by *Trametes polyzona* WR710-1 under solid-state fermentation. Journal of Basic Microbiology 54: 35-43.

Umeno, A. et al. (2013) Singlet oxygen induced products of linoleates, 10- and 12-(Z,E)-hydroxyoctadeca- dienoic acids (HODE), can be potential biomarkers for early detection of Type 2 diabetes. PLOS ONE 8(5), e63542.

Patent Number 6051163（2016) Polyol oxidase and its application to rare sugar production

Patent Number 5463559（2014) Bioactive ragent for improving the physiological function of fungi

Research Area: Applied Life Science
Research Specialization: Microbial Physiology
Name: KIMURA, Yoshio

Keywords: Myxobacteria, signal transduction, ATP synthesis, Novel microbial resources

Recent Research

1. Signal molecules of Myxobacteria.

Fruiting bodies of Myxobacteria

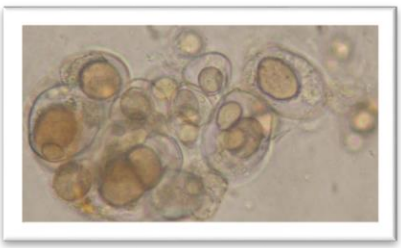
When environmental conditions become unfavorable, organisms produce signal molecules and can respond to changes in their environment.

Diadenosine polyphosphate (Ap_nA; n=3-6) and polyphosphate are produced during amino acid-starvation. We try to identify and characterize key enzymes involved in these signal molecules of synthesis and degradation. Further, we generate gene-broken strains in which the enzyme genes are broken, and we will clarify the function of these enzymes and signal molecules.

On the other hand, we are revealing that these signal molecules are substrates for ATP synthesis enzymes. We now studying that ATP synthesis system using these signal molecules under amino acid-starvation.

2. Isolation of *Sorangium* from the natural world and Search for useful substances.

Isolated the genus *Sorangium*



Gram-negative myxobacteria are an important source of novel classes of secondary metabolites. Of these, the genus *Sorangium* is particularly valuable. Therefore, we are isolating the genus *Sorangium* form soil.

Natural products are extracted from *Sorangium* cultures, and are provided for microbial growth inhibition experiments. In addition, the extracts are analyzed by LC-MS.

we are exploring useful substances from these cultures of *Sorangium*.

Publications

Kimura, Y. et al. (2017). High concentrations of intracellular Ap4A and/or Ap5A in developing *Myxococcus xanthus* cells inhibit sporulation. Microbiology 163:86-93.

Oka, M. et al. (2016). Lysyl-tRNA synthetase from *Myxococcus xanthus* catalyzes the formation of diadenosine penta- and hexaphosphates from adenosine tetraphosphate. Archieves of Biochemistry and Biophysics. 604:152-158.

Sasaki, M. et al. (2014). Enzymatic characteristics of an ApaH-like phosphatase, PrpA, and a diadenosine tetraphosphate hydrolase, ApaH, from *Myxococcus xanthus* enzymes. FEBS Letters 588:3395-3402.

Kimura, Y. et al. (2012). Function analysis of a bacterial tyrosine kinase, BtkB, in *Myxococcus xanthus*. *FEMS Microbiological Letters* 336(1):45-51 (2012).

Mori, Y. et al. (2012). PhpA, a tyrosine phosphatase of *Myxococcus xanthus*, is involved in the production of exopoly-saccharide. *Microbiology*158(10):2546-2555.

Kimura, Y. et al. (2011). A *Myxococcus xanthus* bacterial tyrosine kinase, BtkA, is required for the formation of mature spores. *Journal of Bacteriology* 193(20):5853-5857.

Research Area: Life Science & Biotechnology
Research Specialization : Enzyme Engineering
Name: SAKURABA, Haruhiko

Keywords: hyperthermophiles, archaea, thermostable enzyme,
x-ray crystal structure analysis

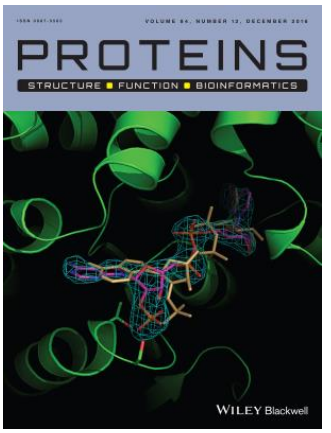
Recent Research

1. Structure-based creation of a novel D-amino acid dehydrogenase

meso-Diaminopimelate dehydrogenase (DAPDH) acts stereoselectively on the D-center of substrate. Thus, the enzyme is expected to be useful for one-step production of D-amino acids, which are often utilized as source materials for industrial production of medicines and agrochemicals. However, its high substrate specificity for DAP and instability have proved to be the major disadvantage for the practical application of DAPDH. Recently, we determined the crystal structure of thermostable DAPDH and estimated the amino acid residues related to substrate binding. We used site-directed mutagenesis to identify the residues responsible for determining the enzyme's substrate specificity and found that a single mutation (D94A) caused a striking change in the substrate specificity of the enzyme. The mutant exhibited extremely high activity for reductive amination of phenylpyruvate. This is a major advantage of using the D94A mutant for one-step synthesis of D-phenylalanine.

2. Unique coenzyme binding mode of hyperthermophilic dehydrogenase

Homoserine dehydrogenase (HseDH) is a key enzyme in the biosynthetic pathway for the synthesis of methionine, threonine, and isoleucine in plants and microorganisms. HseDH is thought to be a potential target for the structure-based design of antibiotics, as the enzyme is not present in mammals. We recently determined the crystal structure of HseDH from the hyperthermophile and found that this enzyme exhibits a new variation on cofactor binding to a dehydrogenase: very strong NADP binding that acts as an obstacle to NAD(P)-dependent dehydrogenase catalytic activity. More recently, we observed another variation on a structural basis for cofactor preference using hyper-thermophilic *sn*-glycerol-1-phosphate dehydrogenase. Our studies indicate that the molecular basis for the cofactor preference in NAD(P)-dependent dehydrogenases may have much more variation than expected.



cover image

Publications

Hayashi, J., *et al*. (2017) Structure-based engineering of an artificially generated NADP-dependent D-amino acid dehydrogenase. ***Applied and Environmental Microbiology***, in press.

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Wakamatsu, T., *et al*. (2016) Structural insights into L-tryptophan dehydrogenase from a photoautotrophic cyanobacterium *Nostoc punctiforme*. ***Applied and Environmental Microbiology,*** in press.

Hayashi, J., *et al*. (2016) Unique coenzyme binding mode of hyperthermophilic archaeal *sn*-glycerol-1-phosphate dehydrogenase from *Pyrobaculum calidifontis.* ***Proteins,*** 84, 1786-1796 .(This study was selected as the cover image.)

Ohshida, T., *et al*. (2016) First characterization of extremely halophilic 2-deoxy-D-ribose-5-phosphate aldolase. ***Protein Expression and Purification***, 126, 62-68 .

Hayashi, J., *et al*. (2015) Crystal structures of a hyperthermophilic archaeal homoserine dehydrogenase suggest a novel cofactor binding mode for oxidoreductases. ***Scientific Reports***, 5, 11674.

Sakuraba, H., *et al*. (2012) Crystal structure of novel dye-linked L-proline dehydrogenase from hyperthermophilic archaeon *Aeropyrum pernix*. ***The Journal of Biological Chemistry,*** 287, 20070-20080.

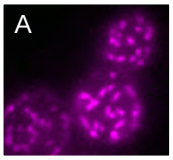
Research Area: Applied Life Science
Research Specialization: Applied Molecular Cell Biology
Name: TABUCHI, Mitsuaki

KEYWORDs: Yeast, eisosome, Stress response, Pathogen effector

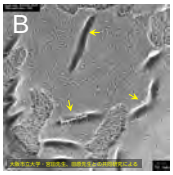
1. Plasma Membrane Stress Response in Yeast

Plasma membrane is constitutively damaged from various physical stresses such as heat stress, osmotic stress, membrane tension, which causes plasma membrane stresses. For example, in humans, myocytes are constantly damaged by exposure to physical membrane stress by repeating expansion and contraction as they move intensely. However, cells have a mechanism to repair such damage. In animal cells, it is known that a structure called “Caveolae” plays an essential role in repairing membrane damage, and caveolae abnormality is known to be a cause of cardiomyopaty.

Yeast is a unicellular eukaryote and has contributed to the elucidation f various intracellular mechanisms such as autophagy as a model eukaryotic cell. Mechanisms for sensing and repairing membrane stress are also present in yeast cells, and “Eisosome” are known as organelles corresponding to caveolae of animal cells. Our laboratory focus on cellular function of eisosome and is interested in the downstream signaling pathway that activates the membrane repair during plasma membrane stress.



A) Yeast Eisosomes are visualized with red fluorescent protein-tagged Pil1 under the fluorescent microscopy.

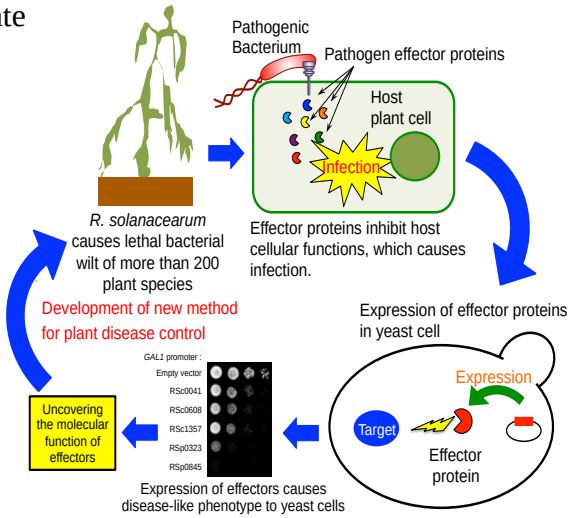


B) Ultrastructure of yeast plasma membrane surface was visualized using electron microscopic analysis. Arrows indicate eisosome structures.

2. Functional Analysis of Pathogen Effector Proteins in Yeast

Numerous bacterial pathogens of plants and animals inject virulence proteins, so-called effetors, directory into the host cell cytoplasm through specialized secretion apparatuses, such as the type III secretion system. The translocated effector proteins manipulate diverse host cellular processes to promote the perturbation of host immune system and ultimately cause infection.

In our laboratory, we are conducting yeast system to uncover the molecular function of effectors from *Ralstonia solanacarum*, which is the most destructive bacterial pathogen in plant. If the effector inhibits the yeast counterpart of the host effector target and then give us a phenotype, such as growth inhibition of yeast. This effector-induced growth inhibition allows us to understand the molecular function of effectors. Recently, by using the yeast system, we found one of the *R. solanacearum* **effector,** RipAY functions as a glutathione degradation enzyme to inhibit host immune response (1, 2).



Publications

1. Popa C., Tabuchi M. and Valls M. Modification of bacterial effector proteins inside eukaryotic host cells. *Front. Cell. Infect. Microbiol.*, **6**, 73, 2016.
2. Fujiwara S., Kawazoe T., Ohnishi K., Kitagawa T., Popa C., Valls M., Genin S., Nakamura K., Kuramitsu Y., Tanaka N. and Tabuchi M. RipAY, a plant pathogen effector protein, exhibits robust γ-glutamyl cyclotransferase activity when stimulated by eukaryotic thioredoxins. *J. Biol. Chem.*, **291** (13), 6813-6830, 2016.
3. Tabuchi M., Audhya A., Parsons A.B., Boone C., Emr S.D. The phosphatidylinositol 4,5-biphosphate and TORC2 binding proteins Slm1 and Slm2 function in sphingolipid regulation. *Mol. Cell Biol.* **15**, 5861-75, 2006.

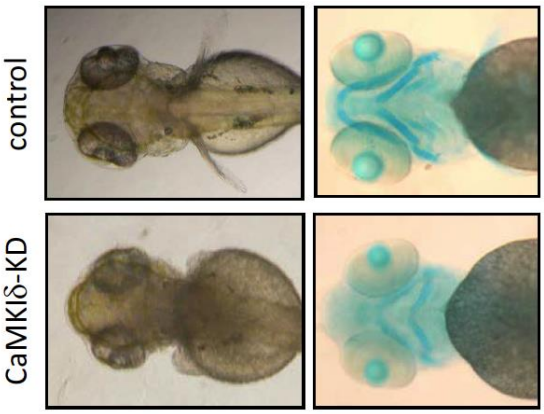
Research Area: Life Science & Biotechnology
Research Specialization: Molecular and Cellular Biology
Name: SUEYOSHI, Noriyuki

KeyWords：Protein Kinase, Protein Phosphatase, Zebrafish

Recent Research

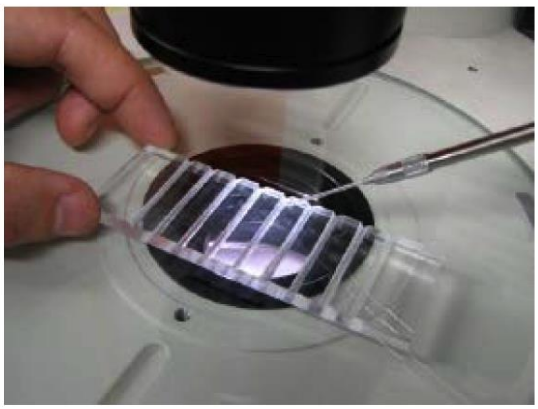
1. Functions of protein kinases and phosphatases on zebrafish embryogenesis.

Protein kinases and phosphatases are known to play pivotal roles in various signaling pathways and to participate in diverse cellular processes including proliferation, development and differentiation. To investigate protein kinases and phosphatases involved in the developmental processes in zebrafish embryogenesis, we are performing functional gene knockdown experiments in zebrafish using antisense morpholino-modified oligonucleotides that is targeted to the 5'-noncoding sequences of various protein kinases and phosphatases.



2. Regulation of PPM family protein phosphatases.

Ca^{2+}/CaM-dependent protein kinase phosphatase (CaMKP) is a Ser/Thr protein phosphatase that belongs to the PPM family. In our laboratory, **we focus on the regulation mechanisms of PPM family phosphatases, especially of CaMKP and CaMKP-N, a nuclear isoform of CaMKP.**



Publications

- Senga and Akizuki *et al.* High-performance CaMKI: A highly active and stable form of CaMKIδ produced by high-level soluble expression in *Escherichia coli*. *Biochem. Biophys. Res. Commun.* 475, 277-282, 2016
- Onouchi *et al.* Regulation of Ca^{2+}/calmodulin-dependent protein kinase phosphatase (CaMKP/PPM1F) by Protocadherin-γC5(Pcdh-γC5). *Arch. Biochem. Biophys.* 585, 109-120, 2015
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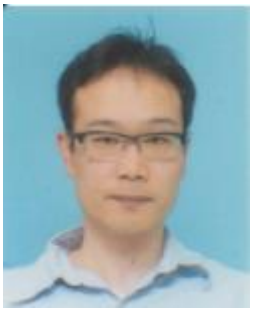
- Sueyoshi *et al.* Functional processing of nuclear Ca^{2+}/calmodulin-dependent protein kinase phosphatase (CaMKP-N): evidence for a critical role of proteolytic processing in the regulation of its catalytic activity, subcellular localization and substrate targeting *in vivo*. *Arch. Biochem. Biophys.* 517, 43-52, 2012
- Senga *et al.* Knockdown of two splice variants of Ca^{2+}/calmodulin-dependent protein kinase Iδ causes developmental abnormalities in zebrafish, *Danio rerio*. *Arch. Biochem. Biophys.* 517, 71-82, 2012
- Onouchi *et al.* Phosphorylation and activation of nuclear Ca^{2+}/calmodulin-dependent protein kinase phosphatase (CaMKP-N/PPM1E) by Ca^{2+}/calmodulin-dependent protein kinase I (CaMKI). *Biochem. Biophys. Res. Commun.* 422, 703-709, 2012
- Baba *et al.* Regulation of Ca^{2+}/calmodulin-dependent protein kinase phosphatase (CaMKP) by oxidation/reduction at Cys-359. *Arch. Biochem. Biophys.* 526, 9-15, 2012

Research Area: Life Science & Biotechnology
Research Specialization: Applied Microbiology
Name: TANAKA, Naotaka



Keywords: fission yeast, Golgi apparatus, secretory pathway, agmatine, glycoprotein

Recent Research

1. Transport control of glycoproteins by lectin-like protein

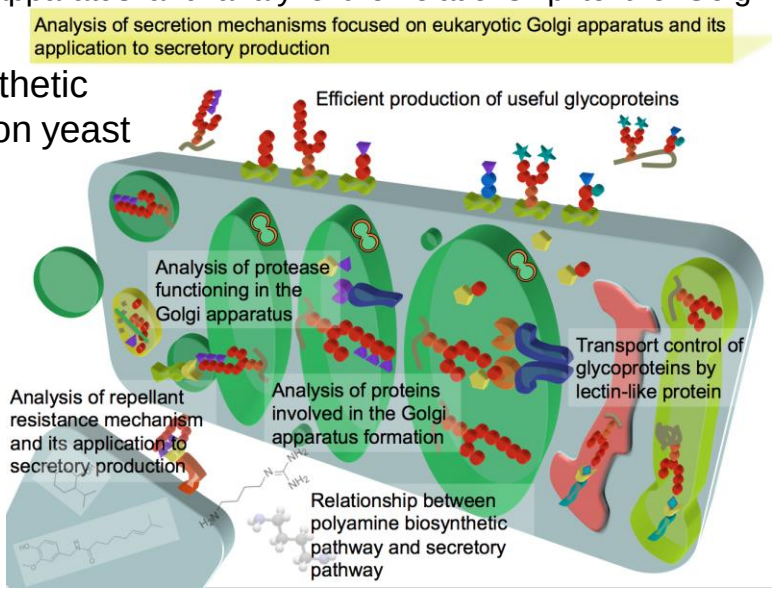
Secreted proteins and membrane proteins are entrapped in transport vesicles in the endoplasmic reticulum, passed through the Golgi apparatus, and transported to the cell surface and suitable organelles. It is known that glycosylation, which is one of posttranslational modifications, is essential for quality control of secreted proteins and packaging in appropriate vesicles. It has been clarified that lectin-like proteins are involved in protein sorting and transport by binding to specific sugar chains, but there are many unclear points about the mechanism that distinguishes cargo proteins and the localization mechanism of lectin-like proteins. We analyze the function of lectin - like protein by analyzing the phenotype indicated by the deficient strain of fission yeast lectin-like protein.

2. Analysis of the Golgi apparatus formation mechanism in fission yeast

The Golgi apparatus of fission yeast is scattered in the form of about 10 to 20 dots in the cell. There is a clear layer in each Golgi apparatus, but not only the layer formation mechanism, but also the mechanisms involved in determining the number of Golgi apparatus and position within the cell are not well understood. We focus on the peripheral proteins of the Golgi apparatus and analyze the relationship to the Golgi apparatus function.

3. Analysis of polyamine biosynthetic pathway via agmatine in fission yeast

Polyamines are involved in cell function in various organisms. Ornithine-mediated pathways are well known, but the physiological role of agmatine-mediated polyamine biosynthesis pathway is relatively unknown. We are trying to clarify the involvement in cell function by inhibiting the metabolic pathway of agmatine.



Click here for more information.

Publications

- Suzuki, S. et al. (2010) Characterization of two different types of UDP-glucose/-galactose 4-epimerase involved in galactosylation in fission yeast. Microbiology 156: 708–718.
- Tanaka, N., et al. (2001) Functional characterization of Gms1p/UDP-galactose transporter in *Schizosaccharomyces pombe*. Yeast 18: 745-757.

Research Area: Applied Life Science
Research Specialization: Microbial Biochemistry
Name: WATANABE, Akira

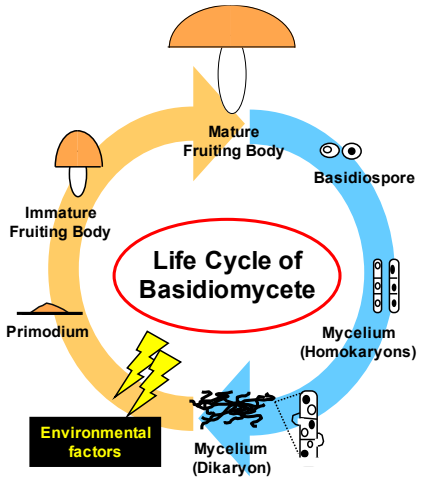
Keywords: Microorganism, Basidiomycetous mushroom, Enzyme, Protein, Gene

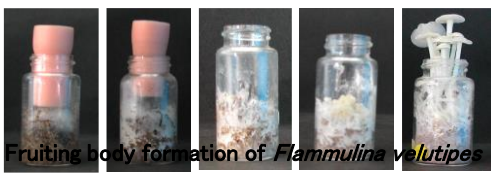
Recent Research

1. Studies on biological characteristics in basidiomycetous mushroom

Basidiomyctes develop a fruiting body (called mushroom) as a large organ that produces many basidiospores (right figures). Fruiting body is formed from the aggregation of mycelia by proper environmental factors. However molecular mechanisms of fruiting body development in basidiomycetes are still unclear. In addition, basidiomycetes are very useful species for application. Because, they include edible, medicinal, and wood-degrading species.

In this laboratory, we study the biological characteristics of basidiomycteous mushrooms.



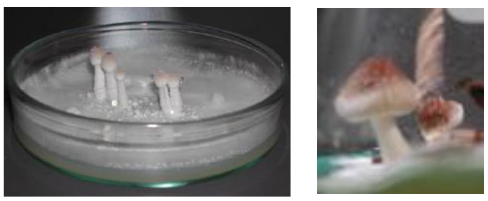


Fruiting body formation of *Flammulina velutipes*

2. Studies on autophagy of basidiomycetous mushroom

Autophagy is a conserved intercellular degradation system in eukaryotes, which mediates the turnover of cytoplasmic proteins. Recent studies indicate that autophagy is involved not only in response to nutritional starvation but also in various biological phenomena such as cell developmental processes, intracellular clearance and organelle metabolism.

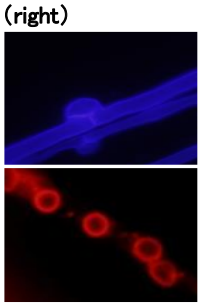
In this laboratory, we study the physiological role of autophagy in basidiomycetous mushroom.



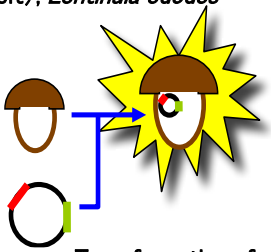
Coprinopsis cinerea(left), *Lentinula edodes* (right)

3. Development of molecular biological tools in basidiomycetous mushroom

We also attempt to develop the efficient molecular tools (the gene / protein level) of basidiomycetous mushroom.



Fluorescence microscopic observation



Transformation of basidiomycetous mushroom

Publications

Chairin, T. *et al*. (2014) Purification and characterization of the extracellular laccase produced by *Trametes polyzona* WR710-1 under solid state fermentation, Journal of Basic Microbiology 54: 35-43.

Chairin, T. *et al*. (2013) Biodegradation of bisphenol A and decolorization of synthetic dyes by laccase from white-rot fungus, *Trametes polyzona*, Applied Biochemistry and Biotechnology 169: 539-545.

Nitheranont, T. *et al*. (2011) Decolorization of synthetic dyes and biodegradation of bisphenol A by laccase from the edible mushroom, *Grifola frondosa*, Bioscience, Biotecnology, and Biochemistry 75: 1845-1847.

Nitheranont, T. *et al*. (2011) Extracellular laccase produced by an edible basidiomycetous mushroom, *Grifola frondosa*: purification and characterization, Bioscience, Biotecnology, and Biochemistry 75: 538-543.

Research Area: Life Science & Biotechnology
Research Specialization: Rare Sugar Enzymology
Name: KATO, Shiro

Keywords: **Rare sugar, Microbial enzyme, Bacteria, Isomerase**

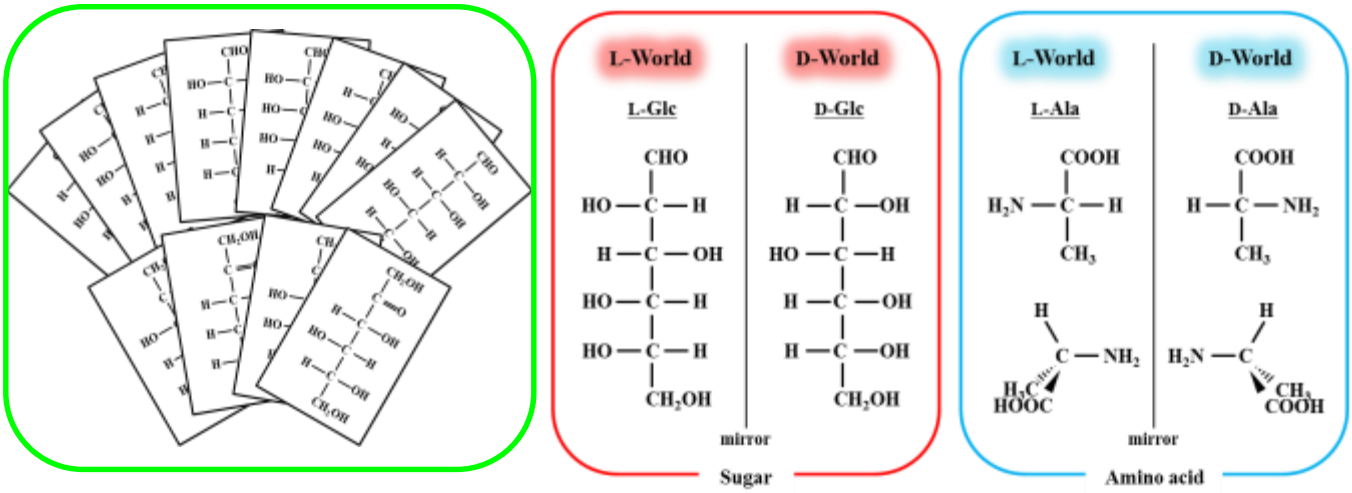
Recent Research

1. Rare sugar production using microbial enzyme

Rare sugar is defined as monosaccharides and its derivatives that exist in the natural world only in a minute amount. Ongoing studies in our laboratory aim to develop production system of rare sugars using microbial enzymes.

2. Biochemical analysis of isomerases

Chiral compounds such as sugars and amino acids exert various physiological effects. However, their origins and functions have not been completely explained yet. Our researches focus on isomerization reactions catalyzed by various isomerases.



Publications

- Kato S, Oikawa T (2017) Genome Sequence of *Lactobacillus sakei* LK-145 Isolated from a Japanese Sake Cellar as a High Producer of D-Amino Acids, Genome Announcements, accepted for publication.
- Kato S, Oikawa T (2017) Genome Sequence of *Leuconostoc mesenteroides* LK-151 Isolated from a Japanese Sake Cellar as a High Producer of D-Amino Acids, Genome Announcements, accepted for publication.
- Washio T, *et al*. (2016) Molecular cloning and enzymological characterization of pyridoxal 5′-phosphate independent aspartate racemase from hyperthermophilic archaeon *Thermococcus litoralis* DSM 5473, Extremophiles, 20, 711-721.
- Kato S, *et al*. (2015) Enantioselective analysis of D- and L-amino acids from mouse macrophages using high performance liquid chromatography, Journal of Pharmaceutical and Biomedical Analysis, 116, 101-104.
- Kato S, *et al*. (2012) Lysine racemase from a lactic acid bacterium, *Oenococcus oeni*: Structural basis of substrate specificity, The Journal of Biochemistry, 152(6), 505-508.
- Kato S, *et al*. (2011) Simultaneous determination of D-amino acids by the coupling method of D-amino acid oxidase with high-performance liquid chromatography, Journal of Chromatography B, 879, 3190-3195.

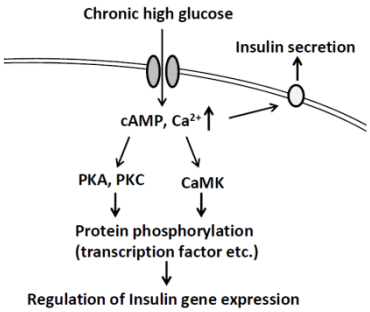
Research Area: Applied Life Science
Research Specialization: Animal cell biology
Name: SUGIYAMA, Yasunori

Keywords : signal transduction, type 2 diabetes, methodology

Recent Research

1. Analysis of molecular mechanisms of glucotoxicity in type 2 diabetes

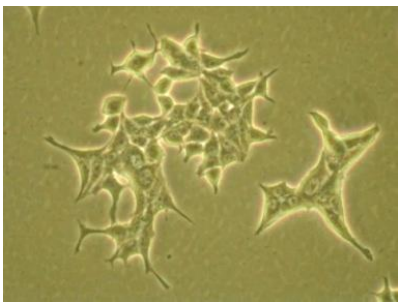
Type 2 diabetes caused by poor lifestyle and genetic factor. Glucotoxicity (impaired insulin secretion and insulin resistance) induced by chronic hyperglycemia accelerates the progression of diabetes. In this laboratory, phosphorylation signaling of glucotoxicity in type 2 diabetes is analyzed by using diabetes model cells and mouse. In our previous studies, we analyzed gene expression in glucotoxicity by microarray, and found the changes in the expression of various genes. In addition, we investigate effects of rare sugars on glucotoxicity.



Signal pathway in pancreatic β cells

2. Development of new analysis methods for phosphorylation signaling

Protein phosphorylation is crucial role in cellular signal transduction. Protein kinase catalyzes phosphorylation of proteins. In the human genome, 518 protein kinase genes were identified, and the enzymes regulate diverse biological phenomena. Previous studies, we developed monoclonal antibodies, designated Multi-PK antibodies, that can recognize multiple protein kinases. Furthermore, the new methods for analysis of phosphorylation signaling were developed.



Type 2 diabetes mode cells

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Publications

Sugiyama. Y., *et al*. (2005) Generation and application of a monoclonal antibody that detects a wide variety of protein tyrosine kinases. Analytical Biochemistry 347:112-120.

Sugiyama. Y., *et al*. (2006) Two-dimensional expression pattern analysis of protein kinases after separation by MicroRotofor/SDS–PAGE. Analytical Biochemistry 359:271-273.

Sugiyama. Y., *et al*. (2010) The DNA-binding activity of mouse DNA methyltransferase 1 is regulated by phosphorylation with casein kinase 1δ/ε. Biochemical journal 427:489-497.

Sugiyama. Y., *et al*. (2011) Calcium/calmodulin-dependent protein kinase IV involvement in the pathophysiology of glucotoxicity in rat pancreatic β-cells. Metabolism 60:145-153.

Kon. N., *et al*. (2014) CaMKII is essential for the cellular clock and coupling between morning and evening behavioral rhythms. Genes & Development 28:1101-1110.

Sugiyama. Y., *et al*. (2015) Expression and phosphorylation state analysis of intracellular protein kinases using Multi-PK antibody and Phos-tag SDS-PAGE. MethodsX 2:469-474.

Research Area: Food Science
Research Specialization : Food Protein Functionalities
Name: OGAWA, Masahiro

Keywords : Olive, rare sugar, egg protein, and polyphenol

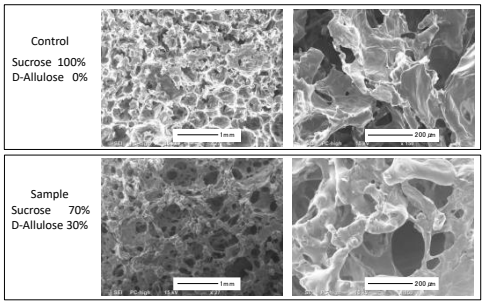
Recent Researches

1. Quality Improvement of Food Products by Olive Leaf Polyphenols

Olive leaf contains a large amount of polyphenols (ca5%). The most abundant polyphenol is oleuropein, which exists only in olive. In Kagawa prefecture, olive leaf powder containing high concentration of polyphenol is fed to aquaculture fish yellowtail. In our laboratory, we evaluate the biochemical (protein-level) and mechanical (breaking force) properties of aquaculture fishes (yellowtail and red sea bream) grown with a feed containing olive leaf powder.

2. Effects of Rare Sugars on Food Processing Properties

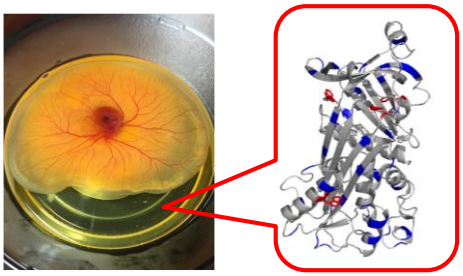
D-Allulose (Alu), also known as D-Psicose, is the C-3 epimer of D-fructose. It is a rare sugar that exists in small amounts in nature. Alu is a non-caloric sweetener (0.39 kcal g^{-1}) with a suppressive effect on postprandial blood glucose elevation. In our laboratory, we investigate the effects of Alu used as a food additive on various food processing properties (mechanical properties of gels including heat induced egg gel, sausage, and surimi gel, and the effects on lactic fermentation and acetic fermentation).



Microscopic images of baked meringue containing rare sugar D-allulose

3. Biological Functions of Egg White Proteins of Chicken Eggs

Chicken egg is a capsule containing all components participating in its embryo development. Some of egg white proteins have antimicrobial activity against bacteria. These antimicrobial proteins prevent bacteria from invading into egg yolk. However, the physiological function of many other proteins except antimicrobial proteins still remain unknown. In our laboratory, we investigate the physiological functions of an egg white protein, called “ovalbumin-related protein X (OVAX)” in chicken egg development.



Sperm egg after Seven days incubation(left)
Tertiary structure of ovalbumin-related protein X (Right)

Publications

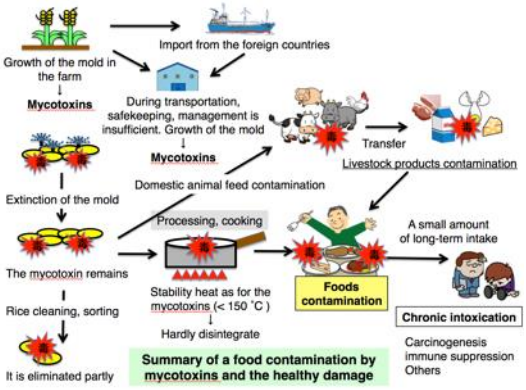
- Ogawa et al. (2017): Effects of rare sugar D-allulose on heat-induced gelation of surimi prepared from marine fish, *Journal of the Science of Food and Agriculture*, DOI: 10.1002/jsfa.8381 *in press*
- Kimoto-Nira et al. (2017): Effects of rare sugar D-allulose on acid production and probiotic activities of dairy lactic acid bacteria, *Journal of Dairy Science* 100(7):5936-5944
- Oyama et al. (2016): Influence of Preservation on Polyphenol Content in Leaves of Olive Cultivars Grown in Kagawa Prefecture, *Nippon Shokuhin Kagaku Kogaku Kaishi*, 63(12), 570-574 (in Japanese)
- Hadipernata et al.(2016): Effect of D-allulose on rheological properties of chicken breast sausage, *Poultry Science* 95(9): 2120-2128
- O’Charoen et al. (2014): Effect of D-Psicose used as sucrose replacer on the characteristics of meringue, *Journal of Food Science* 79(12): E2463-2469

Research Area: **Food Science**
Research Specialization: **Food Hygiene**
Name: **KAWAMURA, Osamu**

Keywords: **Mycotoxin, Microcystine (algae toxin), Monoclonal antibody, Immunoaffinity column, ELISA, Food safety**

Recent Research

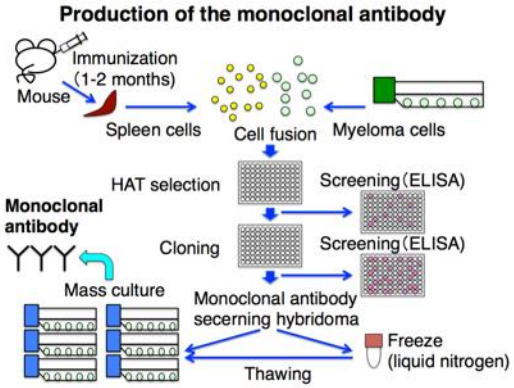
Mycotoxins, the toxic second metabolites of some fungi, give healthy damage to humans and domestic animals. These fungi are infected with the crops in farms, and the fungi grow on per-/post-harvest crops and produce mycotoxins. Mycotoxins remain on the crops after extinction of the fungi, and are heat stable compounds, therefore after cooking, remain in foods. Furthermore, it is known that mycotoxins in animal feeds are transferred to livestock products. A variety of food is contaminated with small quantity of mycotoxins. By an intake of these food for a long term, it is thought that mycotoxins cause the chronic poisoning such as "cancers".



1. Production of monoclonal antibodies against mycotoxins, Development of the immunochemical analysis for mycotoxins in foods, Food contamination investigation, and Risk evaluation

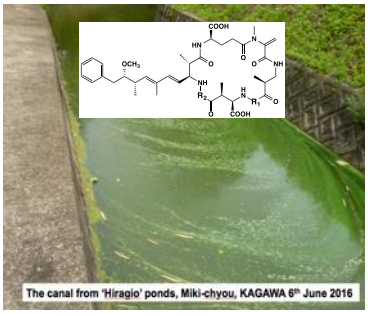
To make clear contamination level of mycotoxins in foods, a simple and easy and high sensitive analysis methods are necessary. Now, the immunochemical methods using antibody are frequently used. We made monoclonal antibodies (mAb) against major mycotoxins, and established immunoaffinity column-HPLC methods using these mAb.

We analyzed mycotoxins in commercial foods, such as rice, coffee, cocoa, and ramen from Japan and Asian countries and feeds for chicken from Brazil and Indonesia We performed behavior experiments of mycotoxin during food processing. We obtained some new findings.



2. Occurrence of algae toxin (microcystine) in fresh water

Microcystin-Leu-Arg (MC-LR) is one of toxic cyanotoxins, which are contaminated with eutrophicated lakes and ponds. We established a sensitive ELISA method for detection of MC-LR in environmental water using our novel mAb. Our best MC.5-3 mAb was a little strongly reacted to MC-RR than MC-LR, and almost same to MC-YR. The sensitivity of our ELISA was 80 pg/mL of MC-LR. This value was less than 1/10 of the regulation level (1 ng/mL) in drinking water by WHO. Using this ELISA, we perform the pollution investigation into reservoirs of Kagawa.



Publications

A. T. Ishikawa, O. Kawamura *et. al.*; Exposure Assessment of Infants to Aflatoxin M_1 through Consumption of Breast Milk and Infant Powdered Milk in Brazil. *Toxins*, 8, 246-256 (2016)

Y. Tbuchi & O. Kawamura; Occurrence of microcystins in Oima Pond and Hirata Pond which were reservoirs in the suburbs of Faculty of Agriculture, Kagawa University. (2014)、Technical Bulletin of Faculty of Agriculture, Kagawa University, 69, 23-26 (2017).

Y. Mistumoto & O. Kawamura; Decrease of ochratoxin A during cooking of Sanuki udon and occurrence of ochratoxin A in commercial Sanuki udon and somen, Technical Bulletin of Faculty of Agriculture, Kagawa University, 69, 27-30 (2017).

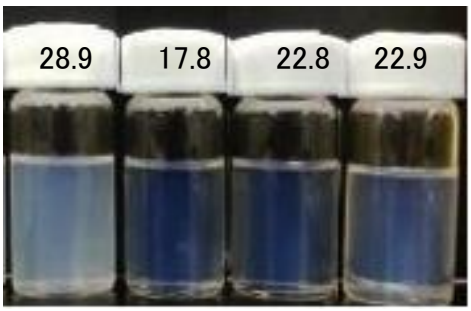
Research Area: Food Science
Research Specialization: Food Physics
Name: GOHTANI, Shoichi

Keywords：emulsion, nanometer, low energy, rheology

Recent Research

1. Preparation of nano-emulsion Using a Low Energy Emulsification Method in Food System

Droplet size (nm)



Nano-emulsions are emulsions whose droplet diameter typically falls in the range of 20–200 nm. The small droplet size and low polydispersity of nano-emulsions is responsible for their transparent or translucent appearance to the naked eye as shown in the figure. Nano-emulsions are highly stable against gravitational separation.

In general, nano-emulsions can be achieved using either high-energy emulsification methods or low-energy emulsification methods. High-energy emulsification methods involve an intensive energy input using a high-shear stirrer, a high-pressure homogenizer or ultrasound generators. Alternatively, low-energy emulsification methods that utilize thermodynamic driving forces have been developed, enabling the formation of nano-emulsions with minimal energy input of mechanical energy. We study the nano-emulsification in food system

2. Rheological Properties of Food

Rheological properties of food is important for food texture which is the response of the tactile senses to physical properties of food. In our laboratory, the effect of composition and preparation method on the rheological properties for food system.

Publications

・Enzymatic esterification of tapioca maltodextrin fatty acid ester, Carbohydrate Polymers, **99**, 379, 2014, Udomrati, S., **Gohtani, S.**

・Phase Behavior and Formation of O/W Nano-Emulsion in Vegetable Oil/ Mixture of Polyglycerol Polyricinoleate and Polyglycerin Fatty Acid Ester/Water Systems, J. Oleo Sci., **63**, 229, 2014, Wakisaka, S., Nakanishi, M., **Gohtani, S.**

・Physical properties of oil-in-water emulsions as a function of oil and soy soluble polysaccharide types, Food hydrocolloid, **39**, 34, 2014, Chivero, P., **Gohtani, S.**, Yoshii, H., Nakamura, A.

・Enzymatic modification and characterization of xylo-oligosaccharide esters as potential emulsifiers, International Food Research J., **22**, 818, 2015, Udomrati, S., **Gohtani, S.**

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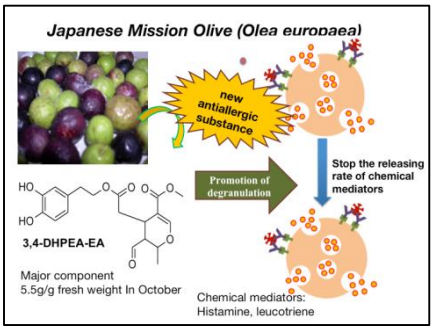
Research Field in Food Science,
Molecular Nutrition and Chemistry on Food materials
Name: TAMURA　Hirotoshi

Key Words : Flavor chemistry, Supramolecular Food Chemistry, antiallergy
Antioxidants, Anti-tumor promotion, Antiobesity

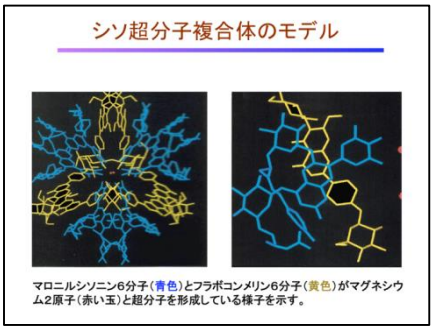
1.　Physiological function of foods materials

Objectives of my research are to focus on development of new technology for isolation and evaluation of physiologically important food ingredients which are produced in local regions in Japan and other countries. Traditional foods bearing physiological functions are our target materials and then collect database and provide the nutraceutical benefits to the local industries. Currently, we succeeded in isolation of antitumor promotion activity, anti-allergic activity, anti-obesity in local products, specially wasting materials from olive, grape, Perilla leaves, yacon leaves and so on



2. Supramolecular Food Chemistry for isolation of polyphenols.

Supramolecules are defined as molecule associated with van der Waals force, ionic bond hydrogen bonding and so on witout covalent bonding. This self-association molecular can be applied in food chemistry and isolation of polyphenols without any sophisticated instrumentsWe succeeded in isolation of Perilla extracts and important food components by this method.



3．Flavor analysis

Aroma is one of essential food functions. Flavor is composed of thousands of trace amounts of compounds and form the characteristic aroma and tastes. Sensation of aroma and tastes has different the impacts on individual judgments. So, scientific approach was difficult. By means of Limited odor unit (Lod) concept, we succeeded in the characterization of citrus, vanilla, coriander and other food aromas. Lod gives just us the information on aroma intensity of each components.

Main research papers

Tamura H.et al., Aroma profile of vanilla in bourbon beans. In “Recent Advances in Food and Flavor Chemistry Food Flavors and Encapsulation, Health Benefits, Analytical Methods, and Molecular Biology of Functional Foods”, (2010), RSC publishing, Cambridge, UK, pp 139-149

Zhu, F., et al., Rosmarinic acid extract for antioxdant, antiallergic and *a*-glucosidase inhibitory activities, isolated by supramolecule technique and solvent extraction from *Perilla* leaves. *J. Agric. Food Chem*., **62**(4), 885-892 (2014).

Asada,T. et al., Isolation techniques for anthocyanidin 3,5-diglucosides and their related chemicals using supramolecules technique, and two solid-phase extraction cartridges. *J.Chromatography A*, **1351**, 21-28 (2014).

Trisonthi, P., et al., A Novel Diterpene from *Litsea cubeba* Fruits: Structure Elucidation and Capability to Induce Apoptosis in Human Cervical Cancer Cell Line (HeLa), *Molecules*, **19** (5), 6838-6850 (2014).

Sato, A., et al. Secoiridoid Type of Antiallergic Substances in the Pomace, Wasting Materials in Three Varieties of Japanese Olive (*Olea europaea*), *J. Agric. Food Chem*., **62**(31), 7787-7795 (2014).

Research Area: Food Science
Research Specialization: Food Nutrition
Name: MATSUO Tatsuhiro

Keywords : carbohydrate and fat metabolism, nutrient, rare sugar

Recent Research

1. Study of functions of rare sugar D-allulose and rare sugar syrup

D-Allulose (D-psicose), a C-3 epimer of D-fructose, is a rare sugar present in small quantities in nature. We have since demonstrated that D-allulose is a sweet carbohydrate that provides no energy and that it causes little toxic effect in rats. In addition, we suggested that D-allulose controls postprandial hyperglycemia in normal and diabetic animals. Thus, D-allulose may be useful in preventing obesity and diabetes in patients. On the other hand, rare sugar syrup (RSS) containing about 6% D-allulose has been sold as a less expensive sweetener in markets. We also showed that RSS reduced abdominal fat accumulation compared to high-fructose corn syrup. We will study mechanisms about the functionality of D-allulose and other rare sugars except D-allulose in future.

2. Effects of very low carbohydrate diet on body fat and metabolism

Recently, a very low carbohydrate diet (VLCD) become the topic through media as a diet cure of diabetes and have been already adopted at some hospitals. It is reported that the VLCD improves a hyperglycemia of the diabetic dramatically in a short term, but is doubted about effects and safety for long-term (several years - life). In addition, it is hardly reported the effect by the long-term intake of the VLCD using the laboratory animals. We have monitored the condition of rats and lifespan using the Goto-Kakizaki (GK) rats that were hereditary type-2 diabetes model rats, but were not able to confirm the life extension effect. We will examine the effects of VLCD using normal Wistar rats equally in future.

3. Study of functional food ingredients

Anti-obesity and anti-diabetes effects of functional food ingredients were studied as follows: (1) fermented brown rice, (2) soy germ protein, (3) egg white and egg white hydrolysate, (4) bonito fish protein, (5) dried Itea plant powder, (6) others.

Publications

・Ochiai M, et al. (2017) Comparison of anti-obesity effect between two types of syrup containing rare sugars in Wistar rats. J Nutr Sci Vitaminol 63: 207-212.
・Ochiai M, et al. (2017) Egg white hydrolysate can be a low-allergenic food material to suppress ectopic fat accumulation in rats fed an equicaloric diet. J Nutr Sci Vitaminol 63: 111-119.
・Hjossain A, et al. (2015) Rare sugar D-allulose: Potential role and therapeutic monitoring in maintaining obesity and type 2 diabetes mellitus. Pharmacl Ther 155: 49-59.
・Ochiai M, et al. (2015) Dietary protein derived dried bonito fish improves type-2 diabetes mellitus-induced bone frailty in Goto-Kakizaki rats. J Food Sci 80, H848-H856.
・Yamada T, et al. (2014) Dietary D-sorbose decreases serum insulin levels in growing Sprague-Dawley rats. J Nutr Sci Vitaminol 60: 297-299.

Research Area: Food Science

Research Specialization: Food Engineering

Name: YOSHII Hidefumi

Keywords：spray drying, encapsulation, molecular encapsulation, emulsion

Recent Research

1. Microencapsulation of food and pharmaceutical related ingredients by spray drying and the storage stability

Among various microencapsulation methods, spray drying is the most common technique to produce flavor powders, since it has many merits such as low process cost, wide choice of carrier solids, good retention of flavors, and good stability of the finished flavors. In this research, the main emphasis of the microencapsulation of flavors has concentrated on preventing the flavor losses during spray drying and extending the shelf life of the products. The focus is on the effect of emulsion droplet size, powder size as well as the type of the model flavors. More specifically the aim is to understand the mechanism loss and oxidation of encapsulated flavor from the droplet which directly relate to the shelf life of product. The work is focused on the effect of water activity as well as the change of the capsule structure on the stability of encapsulated flavor. Furthermore, in order to understand the morphology of spray dried powder and encapsulated flavor powder, CLSM was using to view the cross sectional of the spray dried powder and the arrangement of encapsulated flavor in powder without the destruction of the powders.

2. Encapsulation of flavors by molecular inclusion in cyclodextrins

Cyclodextrin (CD) is a family of cyclic oligosaceharides with truncated molecular structure. The relatively hydrophobic cavity of CD provides a less polar microenvironment in CD solution for the appropriately-sized hydrophobic molecules to reside in. Their applications are mainly intended for the entrapment of smaller molecules, stabilization of reactive intermediates and drug delivery device as potential molecular transport. In food related applications, flavor compounds are being encapsulated into CDs for better retention and protection from various possible means of deterioration, as well as for controlled delivery. HThe aim of this study was to examine the effects of inclusion methods on the properties of inclusion complex powders especially with respect to flavor retention and release of the guest flavor compounds under various temperatures and relative humidities.

Publications

1) Ghani, A. *et al.* (2017) Effect of different dextrose equivalents of maltodextrin on oxidation stability in encapsulated fish oil by spray drying. Biosci. Biotech. Biochem. 81, 705-711.
2) Shiga, H. *et al.* (2017) Effect of oil droplet size on the oxidative stability of spray-dried flaxseed oil powders. Biosci. Biotech. Biochem. 81, 698-704.
3) Phunpee S. *et al.* (2017) Encapsulation of lemongrass oil with cyclodextrins by spray drying and its controlled release characteristics. Biosci. Biotech. Biochem. 81, 718-723.
4) Sultana A. et al. (2017) Microencapsulation of flavors by spray drying using Saccharomyces cerevisiae. J. Food Eng. 199, 36–41.
5) Takashige S. *et al.* (2017) Behavior of flavor release from emulsified d-limonene in spray-dried powders with various wall materials. Japan J. Food Eng., 18, 53 – 58.
6) Nguyen T.V.A. *et al.* (2017) Encapsulation of allyl sulfide with middle–chain triglyceride oil and cyclodextrin by spray drying. Japan J. Food Eng., 18, 35 – 42.

Research Area: Food Science
Research Specialization: Applied Microbiology & Enzyme Chemistry
Name: TAKATA, Goro

Keywords : sugar and sugar related enzyme, rare sugar, oligosaccharide

Recent Research

1. Study on production of rare sugar and rare oligosaccharide

Rare sugar defined as sugar not abundant in nature. Some rare sugars such as D-psicose and D-allose shows various functionalities. These sugars have potential applications for functional foods and medical materials. Our laboratory is now studying on development of novel oligosaccharide production containing both rare sugar and oligosaccharide. This research is a specific research because we have the technical development of rare sugar production.

2. Study on production of functional oligosaccharide

Production of functional oligosaccharides derived from unused resources using enzyme reaction are investigated. Oligosaccharides have various functionalities such as prebiotic effects. We are studying on efficient and low cost production of these sugars using enzymatic reaction.

3. Molecular and structural study of sugar related enzyme

Molecular improvement and catalytic mechanism of enzyme, which is used for production of rare sugar or oligosaccharide are investigated. By gene recombination and X-ray crystal analysis, we are trying to know the catalytic functions, substrate specificities and environmental tolerant. Furthermore, to optimize the enzyme structure by introducing mutagenesis, we are trying to enhance the efficiency of productivity.

Click here for more information

Publications

Uechi, K., **Takata, G.**, Yoneda, K., Ohshima, T., Sakuraba, H. (2014) Acta Crystallographica Section F:Structural Biology Communications, 70 (7), 890-895.
Yoshida, H., Yoshihara, A., Teraoka, M., Terami, Y., **Takata, G.**, Izumori, K., Kamitori, S. (2014) FEBS Journal, 281 (14),3150-3164.
Uechi, K., Sakuraba, H., Yoshihara, A., Morimoto, K., **Takata, G.** (2013) Acta Crystallographica Section D: Biological Crystallography, 69 (12),2330-2339.
Uechi, K., **Takata, G.**, Fukai, Y., Yoshihara, A., Morimoto, K. (2013) Bioscience, Biotechnology and Biochemistry, 77 (3), 511-515.
Morimoto, K., Shimonishi, T., Miyake, S., **Takata, G.**, Izumori, K. (2013) Bioscience, Biotechnology and Biochemistry, 77 (2), pp. 253-258.
Morimoto, K., Terami, Y., Maeda, Y.-I., Yoshihara, A., **Takata, G.**, Izumori, K. (2013) Journal of Bioscience and Bioengineering, 115 (4), pp. 377-381.
Takata, G., Uechi, K., Taniguchi, E., Kanbara, Y., Yoshihara, A., Morimoto, K., Izumori, K. (2011) Bioscience, Biotechnology and Biochemistry, 75 (5), pp. 1006-1009.
Kimura, Y., Yoshimi, M., **Takata, G.** (2011) Journal of Bacteriology, 193 (8), pp. 2053-2057.

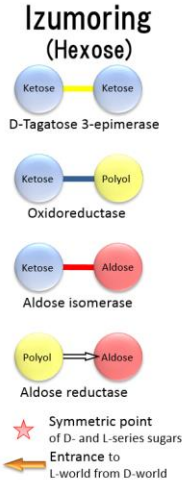
Research Area: Food Science
Research Specialization: Applied Enzymology
Name: MORIMOTO, Kenji

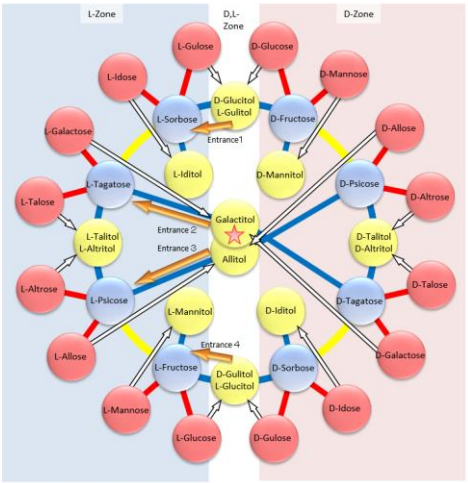
Keywords : Rare sugar, enzyme , separation of rare sugar

Recent Research

1. Screening novel enzyme for rare sugar-producing enzyme

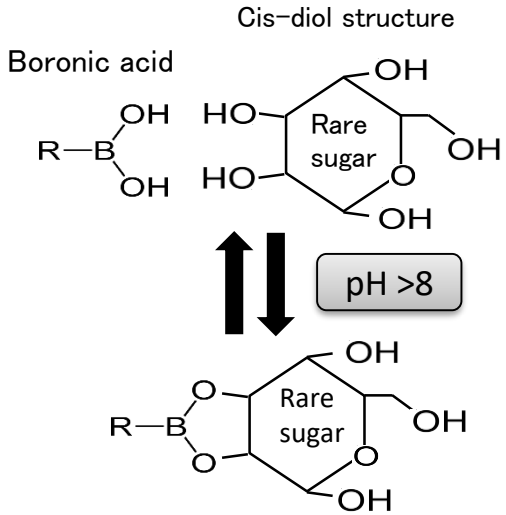
Many enzyme are utilized for rare sugar production as right figure, Izumoring. Each enzyme is derived from microbe and screened from soil. We aim to obtain novel enzymes and more efficient enzyme than existing enzymes.





2. Separation of rare sugar by boronic acid

We are developing novel separation system with boronic acid. Boronic acid has strong affinity with cis-diol structure in sugar molecule under the alkaline pH. This affinity strength is depend on a number of cis-diol structure and its location in molecule, resulting that retention time of rare sugars are different.



3. Hexose synthesis by aldol reaction

Some hexoses can be synthesized from two kinds of trioses by aldol reaction. We study production of novel rare sugars using this reaction.

Publications

- Morimoto, K., Terami, Y., Maeda, Y., Yoshihara, A., Takata, G., Izumori, K.: Cloning and characterization of the L-ribose isomerase gene from Cellulomonas parahominis MB426. Journal of Bioscience and Bioengineering, **115(4),** 377-381, 2013.
- Shompoosang, S., Yoshihara, A., Uechi, K., Asada, Y., Morimoto, K.: Enzymatic production of three 6-deoxy-aldohexoses from L-rhamnose. Bioscience Biotechnology, and Biochemistry, **78(2),** 317-325, 2014.
- Morimoto, K., Yoshihara, A., Furumoto, T., Takata, G.: Production and application of a rare disaccharide using sucrose phosphorylase from Leuconostoc mesenteroides. Journal of Bioscience and Bioengineering, **119(6),** 652-656, 2015.
- Shompoosang, S., Yoshihara, A., Uechi, K., Asada, Y., Morimoto, K.: Novel process for producing 6-deoxy monosaccharides from L-fucose by coupling and sequential enzymatic method. Journal of Bioscience and Bioengineering, **121(1),** 1-6, 2016.

Research Area: Food Science
Research Specialization: Applied enzymology
Name: YOSHIHARA, Akihide

Keywords : Rare sugar, Microbe, Enzyme

Recent Research

1. Screening of microbe and enzyme. Production of rare sugars using their microbe and enzymes

Microbe produces a lot of enzymes. Rare sugars are produced by their biotransformation. Therefore many researchers isolate microbe for effective production of rare sugars. In this research, We screen various rare sugar producing microbes and enzymes. Optimum condition determine for rare sugar production, We try to produce a lot of rare sugars

2. Production of rare sugar derivatives using microbial and enzymatic reaction

Rare sugars are produced by several enzymes. These enzymes are able to classify into following four groups.

・Isomerase catalyzes reversible aldose-ketose isomerization
・Epimerase catalyzes reversible ketose C-3 epimerization.
・Dehydrogenase catalyzes the oxidation of polyols to corresponding ketoses.
・Oxidase catalyzes the oxidation of polyols to corresponding aldoses.

In this research, we try to produce novel rare sugar derivatives that have physiologically activity by microbial and enzymatic reactions. We focus to deoxy monosaccharides, azido monosaccharides and their derivatives.

Publications

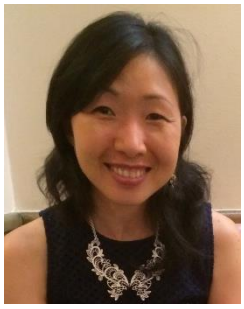
Akihide Yoshihara et al. (2013) Isomerization of deoxyhexoses: green bioproduction of 1-deoxy-D-tagatose from L-fucose and of 6-deoxy-D-tagatose from D-fucose using *Enterobacter agglomerans* strain 221e, Tetrahedron: Asymmetry, 19 (6), 739-745

Pushpakiran Gullapalli et al. (2010) Conversion of L-rhamnose into ten of the sixteen 1- and 6-deoxyketohexoses in water with three reagents: D-tagatose-3-epimerase equilibrates C3 epimers of deoxyketoses, *Tetrahedron Letters*, 51 (6), 895-898

Devendar Rao et al. (2009) A concise approach to the synthesis of all twelve 5-deoxyhexoses: D-tagatose-3-epimerase—a reagent that is both specific and general, Tetrahedron Letters, 50 (26), 3559-3563

Andreas F. G. Glawar et al. (2013) An approach to 8 stereoisomers of homonojirimycin from D-glucose via kinetic & thermodynamic azido-γ-lactones, *Organic & Biomolecular Chemistry*, 11 (40), 6886-6899

Division Food Sciences
Research Field Food chemistry and functionality
Name YONEKURA, Lina



Keywords: Digestion, absorption, bioactive compounds, polyphenols, carotenoids

- *Recent research topics*

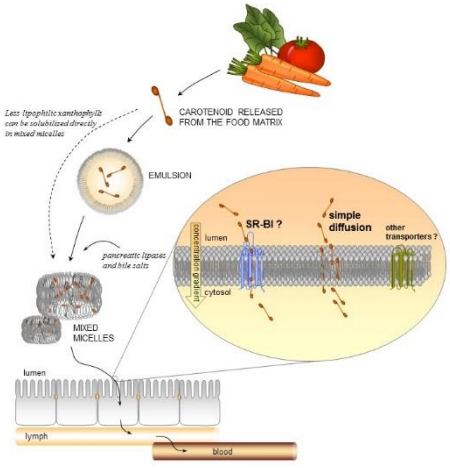
Table olive processing methods for preservation of bioactive compounds

Kagawa prefecture is the largest producer of olives in Japan.

Olive fruits contain important bioactive compounds such as the oleuropein aglycones 3,4-DHPEA-EA and 3,4-DHPEA-EA, which have strong antiallergic effects in addition to their antioxidant properties. However, most of those bioactive compounds are lost with the intensive chemical treatment and rinsing during the process to make table olives. We are studying methods to improve the stability of bioactives in table olives, while reducing the environmental impact of the process by reducing the use of water.

Digestion and absorption of carotenoids and polyphenols

Carotenoids and polyphenols are important food bioactives. Carotenoids are red, orange and yellow pigments that are radical scavengers, antioxidants and have an important role in the prevention of cancer, and age-related macular degeneration. Catechins are also important modulators of the body's redox status.



Carotenoids are poorly absorbed. Only 10-20% of the ingested amount is actually absorbed. The bioavailability of catechins is even lower. We are investigating the effect of dietary factors that can improve the absorption of carotenoids and catechins.

Selected publications

Soukoulis C, Tsevdou M, Yonekura L, et al. (2017). Does kappa-carrageenan thermoreversible gelation affect β-carotene oxidative degradation and bioaccessibility in o/w emulsions? Carbohydrate Polymers 167, 259-269.

Yonekura L, Martins CA, et al. (2016). Bioavailability of catechins from guarana (Paullinia cupana) and its effect on antioxidant enzymes and other oxidative stress markers in healthy human subjects. Food & Function 7, 2970-2978.

Kano S., Komada H, Yonekura L, et al. (2016). Absorption, Metabolism, and Excretion by Freely Moving Rats of 3,4-DHPEA-EDA and Related Polyphenols from Olive Fruits (Olea europaea). Journal of Nutrition and Metabolism 2016, 10.

Kotake-Nara E, Yonekura L, and Nagao A. (2015). Glyceroglycolipids Affect Uptake of Carotenoids Solubilized in Mixed Micelles by Human Intestinal Caco-2 Cells. Lipids 50, 847-860.

Yonekura L, et al. (2016). Vitamina A (retinol) e carotenoides In Biodisponibilidade de Nutrientes (5a EDIÇÃO revisada e atualizada), S.M.F. Cozzolino, ed. (Barueri: Manole), pp. 293-340.