



Takamatsu Rare Sugar Biocluster

# Takamatsu

## Creating a new life science (sugar life science) and sugar bio-industry using "rare sugars"

### Cluster Vision

"Rare sugars" are monosaccharides that occur only rarely in nature, and they come in about 50 types, including D-psicose and D-allose. We have perfected a strategy called "Izumoring" to produce these systematically and have completed design schemes for producing all rare sugars. The rare sugars produced using Izumoring have been discovered to have previously unanticipated bioactivity and new physical/chemical properties. Our aim is the creation of a new "sugar life science" and a "sugar bio-industry" via the mass production of rare sugars and a detailed examination of their bioactivity and physico-chemical properties.

### Project Overview

We have perfected the world's first "Izumoring" production strategy for all rare sugars. All six-carbon rare sugars can be produced using this method. We are making progress in basic and applied research on the bioactivity of rare sugars that we have produced by ourselves. Kagawa (Takamatsu Rare Sugar Biocluster) is the sole area that can produce all rare sugars using the "Izumoring" regime, and we have promoted globally pioneering applications development based on bioactivity and physico-chemical properties.

#### Rare sugar production (We produce all rare sugars independently!)

The process works as follows: from starch to D-glucose, to D-fructose, and then on to the world of rare sugars. D-psicose is the gateway to that world. With D-psicose as a raw material, other new rare sugars, including D-allose and allitol, are then produced. Fourteen types of rare sugars, including D-psicose, an 8 ketohexose kit, and a 10 sugar alcohols kit are now on sale.

#### Applications in food products and sweeteners (More than just sweetness!)

Rare sugars, as sugars, are naturally sweet. But they are more than just sweet: they have also been discovered to have a positive effect on human health. We have revealed that rare sugars prevent diabetes, arteriosclerosis and obesity by suppression of lipid accumulation and hyperglycemia. In this way, rare sugars have the potential to be used in sweeteners and as food products with new functional characteristics.

#### Applications in pharmaceuticals (Creating new pharmaceutical products!)

Rare sugars can be used in other applications in addition to foodstuffs and sweeteners. We have also confirmed their functionality as pharmaceuticals as D-allose. D-allose has a potent inhibitory effect on the production of reactive oxygen species. Its use to protect against ischemia and preserve cells and organs is being studied, and our dreams continue to expand regarding the use of these sugars in new types of drugs.

#### Application to plants (Plants recognize monosaccharides!)

Research has confirmed that plants recognize D-psicose. The fact that monosaccharides have bioactivities on plants was a completely unexpected discovery. Our project has been granted subsidies from the Agriculture, Forestry and Fisheries Research Council, and we have started applied research on safe agricultural chemicals.

Project Director  
**Yoshio Tsujisaka, Ph.D.**



Yoshio Tsujisaka is a former president of Osaka Municipal Technical Research Institute, and a former consultant for Hayashibara Co., Ltd.

## Construction of a global base for research and commercial application of "Rare Sugars" in Kagawa

Rare sugars that have several dozen variations are monosaccharides that have not been previously studied, much less their commercial applications. However, we can produce most rare sugars using "Izumoring" through an intellectual cluster development project. Kagawa (Takamatsu Rare Sugar Biocluster) is the sole area that can produce polysaccharides and rare sugars.

Research on the fundamental properties and bioactivity of rare sugars is at the forefront via the mass production of rare sugars as an experimental material. These research results are expected to be able to contribute to human health and welfare using "rare sugars". Applications development has been promoted in vast fields (foodstuffs (especially, a specified health food), pharmaceuticals, agricultural chemicals, etc).

In this way, the Kagawa area has been recognized as a worldwide base for research on "sugar life science" by world researchers through the establishment of research foundation of rare sugars. Moreover, venture companies and patents on rare sugars have been born, and our dreams are steadily coming true.

However, several problems remain, such as commercial application of our research outcomes, expansion of local industries, and cooperation and collaboration with other clusters.

We will first grapple with and solve these problems, and second develop, and finally form a new carbohydrate bio industry cluster by making steady progress in commercialization of foods and pharmaceuticals using rare sugars.

### Cluster Headquarters

- President.....Takeki Manabe (Governor, Kagawa Prefecture)
- Vice President.....Koji Kondo (Former President of Kagawa University)
- Project Director.....Yoshio Tsujisaka (Former Director, Osaka Municipal Technical Research Institute; Former Consultant, Hayashibara Co., Ltd.)
- Chief Scientist.....Ken Izumori (Director, Kagawa University Rare Sugar Research Center)
- Deputy Chief Scientist...Masaaki Tokuda (Vice Director, Kagawa University Rare Sugar Research Center)

SCIENCE and Technology Coordinator... Satoru Nakano

### Core Organization

Kagawa Industry Support Foundation

### Participating Research Organizations (Bold: Core Research Organization)

- Industry...Fushimi Pharmaceutical Co., Ltd., Teikoku Seiyaku Co., Ltd., Shikoku Research Institute Inc., RyuSyo Industrial Co., Ltd., Hayashibara Co., Ltd., Organo Corporation, Matsutani Chemical Industry Co., Ltd.
- Academia...**Kagawa University**, Nagoya University, Meijo University, Tokushima University, Osaka Prefecture University, Tokushima Bunri University, Helsinki University (Finland), University of Oxford (U.K.), Verona University (Italy)
- Government...AIST Shikoku (National Institute of Advanced Industrial Science and Technology, or AIST), National Agriculture and Bio-oriented Research Organization (NARO, an incorporated administrative agency), Kagawa Prefectural Industrial Technology Center, Kagawa Prefecture Agricultural Experiment Station, Kagawa Prefecture Forestry Research Center, Kagawa Prefecture Livestock Experiment Station, Research Institute for Solvothermal Technology

### Main Results

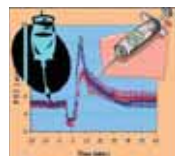
1. Establishment of production techniques for all rare sugars: Now on sale, fourteen types of rare sugars, including D-psicose !!  
We have perfected the "Izumoring" production strategy for all six-carbon rare sugars. Participating industry has begun the sale of fourteen types of rare sugars reagents, including detailed examination of the bioactivity of D-psicose.
2. Applications in functional foodstuffs  
Development of new foodstuffs (specified health foods) has been promoted using the function of D-psicose (non-calorie, suppression of lipid accumulation and hyperglycemia). Functional sweeteners have been developed to prevent obesity and "metabolic syndrome."
3. Development of pharmaceuticals with protective action against ischemic disorders  
The antioxidant action of rare sugars provides effective protection against internal organ disorders that arise from oxygen radicals. We are investigating their effectiveness in various organs and plan to develop applications in injection and intravenous drip fluids.
4. The development of environmentally friendly plant regulators ("eco" agricultural chemicals).  
We have determined that rare sugars help to control the growth of plants and that even small concentrations of rare sugars are effective. We have also learned that rare sugars act to increase the resistivity of plants. Development of novel agricultural chemicals using this action has begun.



Began sale of reagents with rare sugars, including D-psicose



D-psicose: The first candidate for functional foods



Rare sugar injection fluid to provide effective protection against ischemic injuries



Elicitor effects induced by rare sugars

