RYUKOKU UNIVERSITY

Exploring the boundaries of taste

Bringing together renowned chefs from Japan's culinary heartland and world-leading scientists in food palatability, Ryukoku University's new Center for Research on Food Palatability is unravelling the mystery of taste to establish the science of palatability and push the frontiers of Japanese cuisine.

One of Japan's oldest cities and the imperial residence for over a millennium, Kyoto boasts a remarkable depth of tradition and historical continuity that have defined Japanese culture since the eighth century. Back then, as today, cuisine and its mastery are integral to the culture and hallmarks of the Japanese approach to both food and life. Now, Ryukoku University, one of Japan's oldest educational institutions, is taking mastery of the sensory experience of cuisine even further with the country's first Center for Research on Food Palatability.

"Our new centre brings together chefs from renowned Kyoto restaurants and scientists at the forefront of taste research to further our knowledge of palatability and conduct innovative research on Japanese cuisine," says centre director Tohru Fushiki. "We also collaborate with product development researchers from the private sector to tackle problems and challenges specific to these partner corporations. With over 370 years of history in the renowned culinary centre of Kyoto, Ryukoku University is ideally placed to make a global impact in this new interdisciplinary and practical research field."

A food scientist and nutritionist, Fushiki has been studying the detailed mechanics of what makes food palatable for over a decade. From the isolation of taste bud receptors responsible for different tastes, to the olfactory and stimulatory mechanisms in the brain that reward us with feelings of satisfaction and joy in response to pleasing tastes, palatability is a complex and strongly interdisciplinary mystery that Fushiki and his colleagues are intent on deciphering.

Fats and palatability

Increasing the fat and oil content of food is known to make a product tastier and more satisfying, but the physiological and

neurological mechanisms responsible are only just beginning to be revealed. As ingested fats and oils are broken down and absorbed in the gastrointestinal tract, opioids are generated in neurons of the hypothalamus region of the brain — the brain's reward system. In this way, the ingestion of fat results in addictive, reward-seeking behaviour, but the mechanism linking the gut and brain remains unknown.

"Pure fats and oils cannot be discerned by the human senses of taste or smell, but when combined with other ingredients, high-fat foods are perceived as delicious," says Fushiki. "In other words,

highly concentrated fats and oils stimulate the brain's reward system, which in turn amplifies the flavours in food and significantly enhances palatability."

Interestingly, energy-free fat substitutes do not stimulate the same reward system via the gut in this way. Yet recent findings by Fushiki's team suggest that there may be other routes to achieve fat-driven palatability.

"Fatty acids and volatile compounds released by cooking and ageing have a distinctive aroma, which is a key component of the palatability of fats and oils since it signals their presence via olfaction," explains Fushiki. "Our olfactory memories are very stable over long periods and help us recognize food and assess its relative palatability. So by replacing fats and oils with small amounts of fatty acids, it is possible to create foods that have low calorie contents but are still highly palatable. It is discoveries such as these that will become increasingly important for the food industry as it strives to improve palatability while reducing fat and sugar content."

The umami effect

Sweetness, saltiness, acidity and bitterness have long been known as primary tastes for which humans have specific receptors. It was not until the 1980s that a fifth primary taste, known as umami, was named and generally recognized by the scientific community, although it was first scientifically identified in Japan almost a century earlier. Umami is discerned by taste receptors that are specifically stimulated by glutamate — an amino acid found in savoury meat broths and fermented products and the basis for the taste-enhancing effect of monosodium glutamate (MSG). Traditional Japanese cuisine relies heavily on umami in the form of broths prepared using cured bonito fish and *kombu* seaweed, from which MSG was originally isolated. In fact, this prominence of umami gives Japanese food its distinctive palatability and broad global appeal.

"We discovered that the same mechanism by which fats, oils and sugars stimulate the brain's reward system is also present for umami-rich Japanese broth," says Fushiki. "This means that there is a biological preference for the taste of umami, and that the traditional Japanese umami taste can provide the same sense of fullness and satisfaction that sweet and high-fat foods do in Western diets. This explains why traditional Japanese cuisine has relatively low calorie and fat content but remains highly palatable. Because of this, Japanese food can make a positive contribution to the health of people around the world."

Quantifying good taste

A major theme of research at the Center for Research on Food Palatability is the development of methods to quantify the subjective evaluation of taste. As taste preferences vary among individuals, it is difficult to achieve an objective understanding of palatability. The recognition that many aspects of 'deliciousness' reside not with the foodstuff but with the individual has made it possible to achieve some important advances in this area.

"We have demonstrated that palatability can be expressed in terms of four main factors: physiological palatability or the sensation of deliciousness; food culture as shaped by social customs; information on safety and desirability; and the brain's addictive reward system," says Fushiki.

While physiological and brain reward system factors are shared to a significant extent by all humans, cultural and information-related factors are strongly influenced by individual experience and background.

"Based on these factors, we have created a list of questions to assess the palatability evaluations that people consciously and subconsciously make when consuming food. The ability to even roughly measure such a subjective evaluation of the relative deliciousness of a food allows for further improvements in the development of new food products."

Exploring the frontiers of Japanese cuisine

Through the Center for Research on Food Palatability, a group of scientists and renowned chefs from well-established Japanese restaurants in Kyoto has been conducting experiments aimed at finding possibilities for innovation in traditional Japanese cuisine. Using a specially equipped meeting kitchen at Ryukoku University, these culinary experiments explore specific themes over the course of six months or more. The Boundaries of Kyoto Cuisine is a recent example of such a research project, which considered how to simultaneously protect Japanese food culture and engage with globalization.

"We presented the results of our research at a recent public symposium," says Fushiki. "Our audience included professional chefs, people working in the corporate food industry and local government officials. Collaboration with product development researchers from the private sector is a particularly important aspect of our new centre."

Through this cross-disciplinary interaction, the centre has established a platform for developing innovative ideas for novel kinds of cuisine, as well as new culinary techniques for use in traditional cuisine. "We hope our research will help the Japanese food product industry better meet the needs of the elderly, hospital patients, school lunch programmes and people seeking to restrict their calorie intake by providing food options that are healthful and delicious," says Fushiki. "To enhance the quality of life of Japanese citizens, safeguard Japanese food culture and contribute to the development of food products that meet contemporary consumer needs, we need a sophisticated and precise understanding of palatability — that's the mission of the Center for Research on Food Palatability."

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