MC of the symposium:

Ana San Gabriel, D.V.M., M.S.
Scientific Affairs Representative
Umami Information Center

ORGANIZERS:

American Society for Nutrition

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Umami Information Center

Umami was discovered in 1908 by a Japanese scientist Dr. Kikunae Ikeda. In 2008, we celebrated 100th anniversary of Ikeda's discovery. The Umami Information Center (UIC) was established in 1982 to promote the global spread of information on umami. Following its establishment, in April 2007, in order to safeguard its neutrality and ensure its fairness and openness, the UIC has been accredited by a Tokyo Metropolitan Governor's office as a Non-profit Organization (NPO).

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Functional and Sensory Roles of Glutamate in Human Foods

Satellite Symposium of the American Society for Nutrition's Scientific Sessions at Experimental Biology

Friday, April 25, 2014

1:00 – 5:00 pm

San Diego Hilton Bayfront Sapphire 400

Program Chair

Douglas G. Burrin, PhD, USDA Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX

MC & Program Co-chair

Functional and Sensory Roles of Glutamate in Human Foods is a Sponsored Satellite Program held in conjunction with the American Society for Nutrition's Scientific Sessions at EB 2014.

UMAMI INFORMATION CENTER

INTRODUCTION

Program Description

The chemical basis of the unique taste properties referred to as "umami" was ascribed to monosodium L-glutamate more than a century ago. The umami is a dominate taste found in many natural foods, such as meats, cheese and tomatoes. The characteristic savory or umami taste properties of glutamate have been used for decades as a flavor enhancing ingredient added to foods. In recent years, however, the scientific advances in the biology of the umami taste and glutamate function have revealed important new information. Umami is now regarded as a fifth taste along with sweet, sour, bitter and salty. More importantly the discovery of taste receptors and other glutamate receptors along the gastrointestinal tract have begun to unravel the molecular basis for umami taste and how it signals from the gut to the brain. Metabolic studies in humans and other species have also established that glutamate is abundant in human milk and functions as a major energy fuel for the gut epithelial cells. This session will seek to highlight new discoveries about the biological basis for umami taste and glutamate function and how they may influence the taste and nutritional quality of human foods.

Learning Objectives

At the end of this program, attendees will be able to

» Describe the role of glutamate as a flavoring agent in foods.
» Define the molecular basis for umami taste perception and its associated signaling from the gut to the brain.
» Describe other advances in the understanding of glutamate metabolism and molecular actions.

PROGRAM

1:00 – 1:05 PM	Welcome and Introductions Douglas G. Burrin, PhD & Ana San Gabriel, DVM, MS
1:05 – 1:40 PM	The Role of Glutamate as Flavoring Agent in Foods Kumiko Ninomiya, PhD, Umami Information Center
1:40 – 2:15 PM	Molecular Basis of Umami Taste Perception Yuzo Ninomiya, PhD, Kyushu University, Japan
2:15 – 2:50 PM	Metabolic Function of Free Amino Acids in the Mammary Gland and Breast Milk Guoyao Wu, PhD, Professor, Texas A &M, USA
2:50 – 3:05 PM	Break
3:05 – 3:40 PM	Glutamate Metabolism and Function in the Developing Gut Douglas Burrin, PhD, Professor, USDA Children's Nutrition Research Center, USA
3:40 – 4:15 PM	Umami Taste and Regulatory Effect of Free Glutamate In Children Julie Mennella, PhD, Monell Chemical Senses Center USA
4:15 – 4:50 PM	Glutamate as a Signaling Molecule in the Gut-Brain Axis Daniel Tomé, PhD, INRA – AgroParis Tech, France
4:50 – 5:00 PM	Wrap up
5:00 – 7:00 PM	Reception

There will be umami tasting with glutamate rich foods and a vegetable soup served with hors d'oeuvres and beverages.

Kumiko Ninomiya, PhD

Director

Umami Information Center

Biography

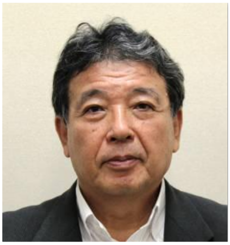
An umami expert, Kumiko Ninomiya has been serving as director of the Umami Information Center, a non-profit organization founded in 1982 in Tokyo that is dedicated to spreading accurate information concerning the umami taste worldwide. With this purpose, she has been invited to conferences around the world and has helped to organize numerous seminars on umami in the US, Europe, South America, Japan and other Asian countries. Kumiko has published articles on umami in Food Reviews International, Physiology and Behavior, and other trade and peer-reviewed journals.

She has also collaborated with chefs and researchers on the traditional Japanese soup stock *dashi* and other soup stocks in various countries, as well as diverse types of umami foods internationally. In all of her work, she aims to contribute to the creation of a global communication network of chefs and scientists to help food research and to enhance the health of people around the world.

The Role of Glutamate as a Flavoring Agent in Foods

Presentation Summary

Since the time of the ancient classics, Democritus, Aristotle and Plato, it was thought that there were only four basic tastes, sweet, sour, salty and bitter. But in the 1800s, came the French chef Auguste Escoffier who created the veal stock, and the gastronome Brillat Savarin who in his book *The Physiology of Taste* described the osmazome concept as the sapid portion of a stock. Soup stocks enriched the flavor of dishes and tasted like no combination of salty, sour, sweet or bitter. It was not until 1908 that the Japanese chemist Kikunae Ikeda identified the ingredient responsible for this taste from kelp that was also common in asparagus, tomatoes, cheese and meat. This ingredient was glutamic acid and Ikeda named the taste of glutamate, umami. Nowadays recognized as the fifth basic taste, umami can be described as a lingering pleasant taste of savory foods with a broad development over the tongue. I will present how scientists and chefs have gained awareness on umami because of its unique properties of balancing and harmonizing all flavors.



Yuzo Ninomiya, PhD

Professor

Kyushu University, Japan

Biography

Dr. Yuzo Ninomiya is distinguished professor of Kyushu University, Japan. Professor Ninomiya studied his undergraduate and doctoral degrees in Animal Physiology at Nagoya University, Japan, and has worked on primates' taste neurophysiology with Prof. Hellekant at Regional Primate Center, Upsala University, Sweden, and Wisconsin University, USA for several years. Since 1999 he has been Head of Department and Professor for Oral Neuroscience at the Department of Oral Neuroscience, Graduate School of Dental Sciences, Kyushu University. His current interests are molecular genetics and neural basis for reception, modulation and transmission of oral-gut taste signals for regulating food intake and energy homeostasis.

Molecular Bases of Umami Taste Perception

Presentation Summary

Umami, first described by Dr. Kikunae Ikeda about a century ago, is the characteristic taste sensation elicited by monosodium l-glutamate (MSG) and 5’-ribonucleotides such as IMP (inositol monophosphate) and GMP (guanidine monophosphate). When added to many fods, these umami substances enhance their palatability. Studies using a variety of approaches indicated that the umami taste is unique, that is distinct from sweet, bitter, sour and salty tastes, and play crucial roles in intake of amino acids. Recent molecular studies have identified strong candidates for umami receptors, the heterodimer T1R1+T1R3, and type 1 and 4 metabotropic glutamate receptors. The finding that human T1R1+T1R3 expressed in HEK293 cells preferentially responds to glutamate, provides strong evidence for T1R1+T1R3 would be a sole receptor for umami detection in humans. However, several studies including ours argue for involvement of mGluRs in addition to T1R1+T1R3 in umami taste detection. In my talk, I will discuss about multiple receptor systems for umami perception by introducing our data from human genetic and mouse molecular and electrophysiological studies.

Guoyao Wu, PhD
Professor
Texas A & M University,
USA

Biography

Guoyao Wu is distinguished Professor of Animal Nutrition, University Faculty Fellow, and Texas A&M AgriLife Research Senior Faculty Fellow in the Department of Animal Science at Texas A&M University. He received a B.S. degree in Animal Science from South China Agricultural University (1978-1982); an M.S. degree in Animal Nutrition from Beijing Agricultural University, China (1982-1984); M.Sc. and Ph.D. degrees in Animal Biochemistry from University of Alberta, Canada (1984-1986 and 1986-1989, respectively). Dr. Wu undertook postdoctoral training in Biochemistry and Nutrition at McGill University Medical School (1989-1991) and at Memorial University of Newfoundland Medical School (1991) in Canada. His research interests include biochemistry, nutrition and physiology of amino acids in animals at molecular, cellular, and whole body levels. Specific research projects include: (1) functions of amino acids in gene expression and cell signaling; (2) mechanisms that regulate intracellular synthesis and catabolism of proteins and amino acids; (3) hormonal and nutritional regulation of metabolic pathways and fuel homeostasis; (4) biology and pathobiology of nitric oxide and polyamines; (5) key roles of amino acids in preventing diabetes and obesity as well as associated vascular complications; (6) essential roles of amino acids in survival, growth and development of embryos, fetuses, and neonates; (7) dietary requirements of proteins and amino acids in the life cycle; and (8) use of animal models for studying human metabolic diseases.

Metabolic Function of Free Amino Acids in the Mammary Gland and Breast Milk

Presentation Summary

Optimal growth and health of suckling neonates critically depend on milk production by their mothers. Results from animal studies indicate that the lactating mammary gland produces more glutamate plus glutamine than their uptake from the arterial circulation and that the opposite is true for branched-chain amino acids (BCAA). BCAA are not only the major components of milk proteins but are also nitrogenous precursors for the synthesis of glutamate, glutamine, alanine and aspartate in mammary epithelial cells. These synthetic pathways contribute to the high abundance of free and peptide-bound glutamate, glutamine, aspartate and asparagine in milk. In contrast, arginine is extensively catabolized in mammary tissue via the arginase pathway to produce proline and polyamines, which are essential to DNA and protein synthesis, as well as lactogenesis. In the pigs, dietary supplementation with BCAA, arginine, glutamine, or glutamate enhances milk synthesis by the lactating mammary gland, thereby enhancing neonatal survival and growth. These findings not only increase our knowledge of lactation biology but also have important implications for improving infant nutrition and development.

Douglas Burrin, PhD
Professor of Pediatrics
USDA Children's Nutrition Research Center,
Baylor College of Medicine, USA

Biography

Dr. Burrin is a Professor of Pediatrics and research physiologist at the U.S. Department of Agriculture/Agricultural Research Service, Children's Nutrition Rearch Center (CNRC) at Baylor College of Medicine (BCM). This CNRC is one of six USDA/ARS human nutrition research centers in the U.S. He is also Director, Fellowship Research Training in the Section of Pediatric Gastroenterology, Hepatology, and Nutrition at BCM. Dr. Burrin is recognized for his knowledge and expertise in basic and translational research encompassing pediatric nutrition and gastroenterology as well as swine nutrition. His research has advanced cutting-edge science in specific areas such as gut growth factor function, gut amino acid metabolism, and most recently the pathobiology and nutritional prevention of pediatric GI diseases. He has authored more than 200 publications and his research is supported by USDA, National Institutes of Health and industry sponsored grants.

Glutamate Metabolism and Function In the Developing Gut

Presentation Summary

Dr. Burrin's research has investigated the metabolic fate of dietary nutrients in the gut, particularly amino acids. We have used sophisticated in vivo approaches with pigs that combined stable isotopes with measurements of substrate flux by the gastrointestinal tissues. This research provided new information on the intestinal nutrient requirements and metabolic fate of dietary amino acids the infant gut. This unique approach highlighted the quantitative significance of gut on the dietary requirement and availability of nutrients to the whole animal. These studies showed that glutamate is a central metabolic fuel for gut metabolism. Our studies in piglets show that most of the dietary glutamate consumed is metabolized in first pass by the gut. More recently, we have focused our research on how glutamate functions in the perinatal gut, as it relates to preterm infants. The presentation will discuss how luminal mucosal nutrient sensing pathways may mediate the actions of dietary glutamate on neonatal nutrition and gut function.

Julie Mennella, PhD
Monell Chemical Senses Center,
USA

Biography

Dr. Mennella obtained a Ph.D. from The University of Chicago. She subsequently did postdoctoral work at the Monell Center and then joined the faculty there in 1990. Her research focuses on early life because of the importance of this time period for programming later health outcomes and for preventive interventions. Current research programs are investigating the effects of early experiences on flavor learning, satiation and growth and the role of genetics and age on taste perception, dietary preferences and medication acceptance. In addition to her research, she founded and directed a program that encouraged under-represented minority high school and undergraduate students to pursue careers in science. She has published more than 200 research papers and book chapters. Her research is currently funded by grants from the National Institute of Health.

Umami Taste and Regulatory Effect of Free Glutamate in Children

Presentation Summary

The composition of the diet fed during early infancy plays a role in both short- and long-term health outcomes. Breast milk is by far the preferred source of early nutrition, and for reasons not completely understood, the mammary tissue has evolved to produce large amounts of non-protein nitrogenous compounds including free amino acids (FAA). While the prevalence of breast feeding is increasing, many infants receive infant formula. Formula-fed infants (most of whom are fed cow milk formula; CMF) tend to weigh more by then end of the first year of life and have a greater risk for obesity than do breastfed infants. However, not all formulas are alike since those who were randomized to feed an extensively hydrolyzed protein formula (ePHF; which is rich in FAA), showed growth rates similar to breastfed infants. In this talk, I will review the findings from experimental studies that revealed that infants satiate on smaller volumes of ePHF compared with CMF. Levels of the FAA glutamate, when added to CMF, were sufficient to account for the intake differences and the timing of the behavioral displays of satiation.

Daniel Tomé, PhD
Professor of Human Nutrition,
President, Department of Life Sciences and Health, France

Biography

Daniel Tomé is professor in Human Nutrition at Paris Institute of Technology for Life, Food and Environmental Sciences (AgroParisTech) and is also the Director of the Nutrition Physiology and Feeding Behavior Laboratory (INRA). He has a background in biochemistry, physiology, food science and Nutrition. His research is focused on protein and amino acid requirements and metabolism. He has authored more than 300 peer-reviewed papers. He is among the experts involved in the evaluation of protein and amino acid requirements for human.

Glutamate as a Signaling Molecule in the Gut-brain Axis

Presentation Summary

Glutamate is extracted by the intestinal mucosa as fuel for intestinal tissue and is also associated to umami taste perception. Sensor systems for free glutamate exist in both taste cells and gut mucosa and could contribute to gut intestinal glutamate and protein signals. Gastric or intestinal infusions of glutamate enhance the firing rate of afferent fibers from the vagus nerve and a specific sensing system for glutamate has been described in the gastric mucosa. Intra-gastric infusion of glutamate induces preference for a flavor paired with intra-gastric self-infusions of mono-sodium glutamate (MSG) and this effect was suppressed by abdominal vagotomy. This is associated to the activation of different brain area including the insular cortex, limbic system, hypothalamus, nucleus tractus solitaries, and amygdala. Current results indicate that glutamate signaling via gustatory and visceral pathways could play a role as a digestive signal acting through the gut brain axis.