The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd. The original Japanese text shall prevail in case of any discrepancy.

HMPA Forum 2026
"The Cutting Edge of HMPA Research: Reaching Out to the World"

Date: Friday, March 13, 2026, 1:00 PM – 5:30 PM
Venue: Auditorium, 3rd Floor, The National Art Center, Tokyo
(7-22-2 Roppongi, Minato-ku, Tokyo)

Program

1:00 PM – 1:10 PM	**Opening Remarks**
1:10 PM – 2:00 PM	**Elucidation of the HMPA Production Mechanism in Lactic Acid Bacteria and Its Application to Production** **Ryoji Mitsui,** Professor, Faculty of Life Sciences, Okayama University of Science
2:00 PM–2:50 PM	**Energy Metabolic Functions of HMPA Mediated by GPR41** **Ikuo Kimura,** Professor、Laboratory of Molecular Neurobiology, Graduate School of Biostudies, Kyoto University
2:50 PM–3:05 PM	**Break**
3:05 PM–3:55 PM	**Bioavailability of HMPA** **Toshiro Matsui,** Professor、Department of Bioscience and Biotechnology, Faculty of Agriculture, Graduate School of Kyushu University
3:55 PM–4:15 PM	**The Antioxidant Activity of HMPA and the Effects of Conjugation** **Hiroyuki Sakakibara,** Professor, Graduate School of Agricultural Science, Kobe University
4:15 PM–4:25 PM	**Break**
4:25 PM–4:40 PM	**HMPA: A Functional Polyphenol Metabolite Produced by Gut Bacteria** **Hiroyuki Kayaki,** Researcher, Maruzen Pharmaceutical Co., Ltd. Research Institute
4:40 PM–4:55 PM	**The Efficacy of HMPA on Cognitive Function** **Rikiya Shiwaku,** Researcher, Maruzen Pharmaceutical Co., Ltd. Research Institute
4:55 PM–5:10 PM	**HMPA Analysis Techniques in Foods** **Hiroaki Kawamoto,** Researcher, Maruzen Pharmaceutical Co., Ltd. Research Institute
5:10 PM–5:15 PM	**Q&A**
5:15 PM–5:20 PM	**Closing Remarks**

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丸善製薬株式会社
MARUZEN PHARMACEUTICALS CO., LTD.

[Tokyo]
2-6-7 Ebisu-Nishi, Shibuya-ku, Tokyo150-0021
TEL (03) 3496-1521 FAX (03) 3496-1641

[Osaka]
2-6-6 Dosho-machi, Chuo-ku, Osaka541-0045
(Shiono Nissei Building 6F)
TEL (06) 6203-6918 FAX (06) 6233-3606

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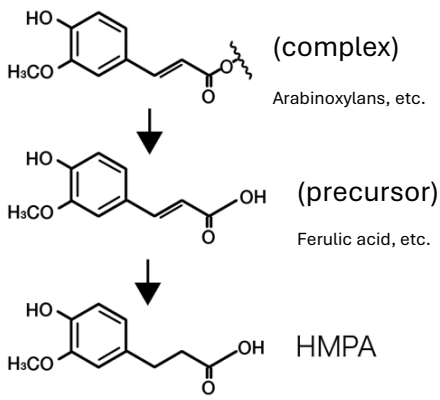
Elucidation of the HMPA Production Mechanism in Lactic Acid Bacteria and Its Application to Production

Ryoji Mitsui
Okayama University of Science, Faculty of Life Sciences, Department of Biological Sciences

3-(4-Hydroxy-3-methoxyphenyl)propionic acid (HMPA) is attracting attention as a functional food ingredient with excellent biological activity. HMPA is a compound formed when the propenoic acid side chain of ferulic acid—found in plant cell walls and other sources—is reduced to propionic acid (see figure below); within plants, it exists primarily as a bound precursor.

Therefore, it is , but it is produced in the gut through the metabolism of gut bacteria following the consumption of fermented foods or foods , it is produced through the metabolism of intestinal bacteria (reduction via ferulic acid), and it has been reported to be detectable in serum and urine. Sources of HMPA include arabinoxylan in whole grains, as well as chlorogenic acid found in coffee , curcumin in turmeric, and γ-oryzanol derived from rice bran, are known to be converted into HMPA by gut bacteria. Therefore, to benefit from the functional properties of HMPA, it is effective to either maintain a gut microbiota capable of converting bound precursors or to ingest HMPA directly. However, knowledge regarding the bacterial species involved in HMPA production and the detailed mechanisms of its production has been limited to date.



We discovered that plant-derived lactic acid bacteria possess the ability to produce HMPA from ferulic acid, and have elucidated their metabolic pathways and associated enzyme groups, particularly using *Lactiplantibacillus plantarum* and *Weissella cibaria*. Both strains are frequently isolated from plant-based fermented foods, but the former undergoes homolactic fermentation, while the latter undergoes heterolactic fermentation. When these strains were cultured in the presence of ferulic acid, both produced HMPA only under fermentation conditions, and a decrease in lactic acid production was observed simultaneously. This revealed that HMPA production proceeds in an antagonistic manner with lactic acid fermentation.

On the other hand, ferulic acid-induced genes differed between strains, suggesting that the enzymes and metabolic pathways involved depend on each strain’s fermentation mode. In particular, the hetero-lactic acid fermentation strain *W. cibaria* was found to be suitable for the fermentation production of HMPA, as it lacks the genes for producing the byproduct 4-vinylguaiacol and possesses the ability to efficiently produce HMPA. In this forum, based on details regarding the enzymes and metabolic pathways involved in HMPA production, we would like to outline the physiological significance of lactic acid bacteria producing HMPA from a fermentation physiological perspective.

The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd.

Ryoji Mitsui

Professor, Faculty of Life Sciences, Okayama University of Science

Education

1993: Graduated from the Department of Applied Biological Engineering, Faculty of Engineering, Tottori University

1998: Completed the Doctoral Program in Agricultural Chemistry, Graduate School of Agriculture, Kyoto University
Completed the Doctoral Program in Agricultural Chemistry, Graduate School of Agriculture, Kyoto University; Ph.D. (Agricultural Sciences)

Work Experience

1998: Research Assistant, Faculty of Science, Okayama University of Science
2005: Visiting Lecturer, Department of Chemical Engineering, University of Washington
2016: Professor, Faculty of Science, Okayama University of Science
2022: Professor, Faculty of Life Sciences, Okayama University of Science

Professional Affiliations

Japanese Society of Agricultural Chemistry
Japanese Society for Microbial Ecology
The Society for Biotechnology, Japan
The Japanese Society for Food Science and Technology
American Society for Microbiology

Awards and Honors

2004: Bioindustry Association Encouragement Award

The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd.

Energy Metabolic Functions of HMPA by GPR41

Ikuo Kimura
Laboratory of Molecular Neurobiology, Graduate School of Biostudies, Kyoto University

4-Hydroxy-3-methoxycinnamic acid (HMCA) is a hydroxycinnamic acid derivative widely found in plant-based foods such as fruits, vegetables, rice bran, and coffee beans, and is known as a representative type of polyphenol. Polyphenols have been reported to possess diverse physiological activities, such as antioxidant and anti-inflammatory effects, and HMCA has also been suggested to be involved in health-promoting functions. However, its detailed mechanism of action and the specific functional molecules involved in vivo had not been fully elucidated. In this study, we demonstrated that HMCA intake significantly suppressed obesity and hepatic steatosis (fatty liver) induced by a high-fat diet, while also improving insulin sensitivity. It was demonstrated that these metabolic improvements are not solely due to the action of HMCA itself, but are based on an indirect mechanism mediated by metabolic conversion by gut bacteria. Specifically, 3-(4-hydroxy-3-methoxyphenyl)propionic acid (HMPA), which is produced when HMCA is metabolized by gut bacteria, played a crucial role as the primary active molecule in vivo. Further detailed analysis revealed that HMPA selectively activates GPR41, one of the short-chain fatty acid receptors. It is known that GPR41 activation enhances lipid metabolism-related pathways, contributing to increased energy expenditure and suppression of fat accumulation. This study also demonstrated that the anti-obesity effects and suppression of fat accumulation in the liver are exerted through GPR41 stimulation by HMPA.

Based on these results, it is suggested that HMCA is converted to HMPA through metabolism by gut bacteria, and that HMPA contributes to the prevention of metabolic diseases, including obesity and fatty liver, by regulating lipid metabolism via GPR41. This study presents a new molecular basis linking dietary polyphenols, gut bacteria, and receptor signaling, and provides important insights into the utility of HMPA as a functional food ingredient.

The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd.

Ikuo Kimura

Professor, Laboratory of Molecular Neurobiology, Graduate School of Biostudies, Kyoto University

Education

2001: Graduated from the Faculty of Pharmaceutical Sciences, Kyoto University
2006: Completed the Ph.D. program at the Graduate School of Pharmaceutical Sciences, Kyoto University)

Work Experience

2006: Research Assistant/Assistant Professor, Department of Applied Pharmacology, Faculty of Pharmacy, Chiba Institute of Science
2008: Assistant Professor, Division of Pharmacogenomics, Graduate School of Pharmaceutical Sciences, Kyoto University
2011: University of California, San Diego, School of Medicine
Department of Reproductive Neuroendocrinology, Visiting Researcher (concurrent position)
2013: Tokyo University of Agriculture and Technology, Graduate School of Agricultural Science, Department of Applied Biochemistry
Metabolic Function Control, Tenure-Track Associate Professor
2019: Tokyo University of Agriculture and Technology, Graduate School of Agricultural Science, Department of Applied Biochemistry
Metabolic Function Control, Professor
2020: Kyoto University, Graduate School of Life Sciences, Division of Biosystems Science
Professor (Concurrently serving in the Department of Metabolic Genomics, Faculty of Pharmaceutical Sciences)
Present

Professional Affiliations

- The Japanese Society of Endocrinology
- The Pharmaceutical Society of Japan
- Japanese Society for the Study of Obesity
- Japanese Society of Gut Microbiology
- Japanese Society of Nutrition and Food Science

Awards and Honors

- 2016 Minister of Education, Culture, Sports, Science and Technology Award for Young Scientists
- The 15th Genpaku Sugita Award
- FY 2022 Minister of Education, Culture, Sports, Science and Technology Award: Science and Technology Award (Research Category)

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Bioavailability of HMPA

Toshiro Matsui

Department of Bioscience and Biotechnology, Faculty of Agriculture, Graduate School of Kyushu University

Phytochemicals, a general term for plant defense compounds, refer to primary and secondary metabolites, and polyphenols are one of the major types of phytochemicals. Although vegetable consumption has been recommended in recent years for maintaining health, the biological behavior and health effects of the phytochemicals they contain remain poorly understood. One factor that further complicates our understanding of the bioavailability of these non-nutrient compounds is the metabolic response following ingestion. Phytochemicals undergo Phase I and II metabolic reactions in the intestines, mesentery, and liver, and are subsequently directed toward the excretory system, including urine. Recent trends in polyphenol absorption research highlight the importance of: 1) quantitative assessment of absorption and excretion; 2) understanding the role of the gut microbiota in polyphenol metabolism; and 3) investigating methods to improve bioavailability, such as nanoparticle encapsulation (*Ann. Rev. Food Sci. Technol.*, 16: 315, 2025). However, it is impossible to fully grasp the entire picture of polyphenol metabolism and physiological functions; for example, 33 types of breakdown products and metabolites are qualitatively detected in the blood for the anthocyanin Cy3G (*Br. J. Pharmacol.,* 171: 3268, 2014), and 17 types for the phenolic glycoside CS (*J. Agric. Food Chem.*, 59: 6288, 2011). On the other hand, 3-(4-hydroxy-3-methoxyphenyl)propionic acid (HMPA) is known as an intestinal bacterial metabolite commonly produced from multiple bioactive polyphenols, particularly flavonoids, and may act as a key substance in unraveling the physiological effects of polyphenols. However, the bioavailability of HMPA, which is necessary for understanding its physiological effects, remains unknown, and there has been virtually no discussion regarding its metabolites.

Therefore, this presentation will introduce the bioavailability of polyphenols, including HMPA, and their metabolites. Following a single-dose administration test in rats (10 mg/kg-BW), HMPA is not only absorbed in its original form (metabolite composition: 38%) but also undergoes rapid metabolic reactions, circulating in the body as sulfate conjugates (57%) and glucuronide conjugates (5%). Furthermore, accumulation in organs (liver, kidneys, sole muscle, lungs, blood vessels, and heart) was observed, demonstrating that metabolites can also be distributed to organs (total HMPA absorption: >1.2%) (*Biosci. Biotecnol. Biochem.*, 87: 516, 2023: Editor’s selected cover photo). These findings suggest that metabolites may exert physiological effects in tissues, and we would also like to mention an example of their action in blood vessels using human umbilical vein endothelial cells (HUVEC) (*ACS Omega*, 10: 2887, 2025).

The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd.

Toshiro Matsui

Professor, Department of Bioscience and Biotechnology, Faculty of Agriculture, Graduate School of Kyushu University

Education

1986: Graduated from the Faculty of Agriculture, Kyushu University
1988: Completed Master's Program, Department of Food Science and Engineering, Graduate School of Agriculture, Kyushu University
1991: Completed the Ph.D. program in Food Science and Engineering, Graduate School of Agriculture, Kyushu University

Work Experience

1991: Research Assistant, Faculty of Agriculture, Kyushu University
2000: Associate Professor, Graduate School of Agricultural Science, Kyushu University
2011: Professor, Graduate School of Agricultural Science, Kyushu University

During this period, Visiting Researcher at the German Institute of Food Chemistry (Ministry of Education), Department of Food Science and Engineering, Tianjin University of Science and Technology Special Foreign Professor, China's National 111 Project Director, Center for Research and Development of Applied Sensory Devices, Kyushu University Concurrently

Present

Professional Affiliations

- The Japanese Society for Food Science and Technology
- Japanese Society of Nutrition and Food Science
- The Japanese Society of Agricultural Chemistry
- Japanese Society of Hypertension, etc.

Awards and Honors

2011: The Society of Food Science and Technology of Japan, Technical Award
2016: Technical Award, Japanese Society of Nutrition and Food Science
2019: The Society of Analytical Chemistry, Japan; Kyushu Society of Analytical Chemistry Award
2020: Momofuku Ando Award, Excellence Award
2022: Iijima Tojuro Food Science Award
2023: Minister of Education, Culture, Sports, Science and Technology Commendation, Science and Technology Award
2023: Society Award, The Society of Analytical Chemistry, Japan
2024: Society Award, Japanese Society of Nutrition and Food Science
2025: Medal with Purple Ribbon
etc.

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The Antioxidant Activity of HMPA and the Effects of Conjugation

Hiroyuki Sakakibara

Organization for Engineering Biology,

Graduate School of Agricultural Science, Kobe University

When evaluating the functionality of food components, it is not necessarily the case that ingested components act directly within the body. It is essential to consider which molecular species are actually present in the body and exert their functions after undergoing a series of physiological processes such as digestion, absorption, metabolism, and excretion. However, in conventional research on food functionality, evaluations have largely focused on unchanged compounds, and it cannot be said that comprehensive discussions incorporating the contributions of metabolites and conjugates have been sufficiently conducted.For example, chlorogenic acid is a representative polyphenol abundant in many plant-based foods, including coffee and burdock root. Due to its strong antioxidant activity, numerous research findings have been reported regarding its association with the prevention of lifestyle-related diseases and the maintenance of health. On the other hand, it is known that chlorogenic acid undergoes hydrolysis and metabolism by intestinal bacteria in the gastrointestinal tract, converting into low-molecular-weight phenolic acids such ascaffeic acid, dihydrocaffeic acid, and 3-(4-hydroxy-3-methoxyphenyl)propionic acid (HMPA). After these metabolites enter the bloodstream, they undergo conjugation reactions such as sulfation and glucuronidation, primarily in the liver, and exist in the body as molecular forms different from the unchanged compound. Thus, although a variety of metabolites and conjugates are continuously generated after chlorogenic acid intake, systematic evaluations regarding changes in the antioxidant functions of each molecular species—particularly the effects of metabolism and conjugation on antioxidant activity—have not been sufficiently conducted. In particular, regarding HMPA and its conjugates, which have been attracting attention in recent years, while it has been reported that their concentrations in the body are relatively high, their functional significance remains largely unclear.

In this presentation, we will focus on the metabolic cascade of chlorogenic acid and its major metabolites—caffeic acid, dihydrocaffeic acid, HMPA, as well as the sulfate and glucuronide conjugates of HMPA—and present findings comparing changes in antioxidant activity. When using chlorogenic acid as a reference, while some molecular species exhibit enhanced antioxidant activity following metabolism, it was suggested that conjugation may significantly reduce or even eliminate antioxidant activity. These results indicate that the simple equation “antioxidant capacity of ingested polyphenols = antioxidant capacity exerted in vivo” does not necessarily hold true.

Currently, to gain a more comprehensive understanding of the roles played by HMPA and its conjugates in the body, we are conducting analyses using cultured liver cells and are also investigating the possibility of new physiological functions beyond antioxidant activity. In this presentation, I would like to discuss the importance of functional evaluations that focus on the “post-metabolic state” of food components.

The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd.

Hiroyuki Sakakibara

Professor, Graduate School of Agricultural Science, Kobe University

Education

1993: Graduated from Hyogo Prefectural Seiryo High School
1997: Graduated from the Department of Biological Resources, Faculty of Agriculture, Ehime University
1999: Completed Master's Program, Graduate School of Natural Science and Technology, Kobe University
2002: Completed the Doctoral Program, Graduate School of Natural Science and Technology, Kobe University

Work Experience

2003: Postdoctoral Researcher, French National Institute for Agricultural Research (INRA/Clermont-Ferrand)
2005: COE Researcher, Graduate School of Health Bioscience, Tokushima University
Research Assistant/Assistant Professor, Institute of Environmental Science, Shizuoka
2006: Prefectural University
Associate Professor, Faculty of Agriculture, Miyazaki University
2012: Professor, Faculty of Agriculture, Miyazaki University
2016: Royal Society of Chemistry
2020: Associate Editor, Food & Function — Present
2024: Professor, Graduate School of Agriculture, Kobe University — Present
2024: Professor Emeritus, Miyazaki University — Present
2025: Director, General Incorporated Association of Organization for Engineering Biology

Present

Professional Affiliations

- The Japanese Society of Agricultural Chemistry
- Society for Lipid Peroxidation and Free Radicals
- Japanese Society for Food Factors / Japanese Society of Vitamins
- Vitamin E Research Society
- Japanese Society of Nutrition and Food Science
- Japanese Society for Laboratory Animal Science
- The Society for Molecular Biology of Japan
- Japanese Society of Toxicology

Awards and Honors

- 2nd Miyazaki Tech Plan Grand Prix, Mitsui Chemicals Award, November 2018
- 2010 B.B.B. Paper Award (*Biosci Biotechnol Biochem*. 2010, 25(2), 180-187)
- 2007 Science Exchange Forum (9th Shizuoka Life Science Symposium) Poster Award
- Poster Award, ICoFF2007, December 2007
- Young Researcher Award, 20th General Meeting EGF2004, Lund Use Systems in Grassland Dominated Regions, June 2004
- Young Scholar Award (Ochi Foundation), 3rd International Conference on Food Factors, December 2003

The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd.

HMPA: A Functional Polyphenol Metabolite Produced by Gut Bacteria

Hiroyuki Kayaki

Maruzen Pharmaceutical Co., Ltd. Research Institute

TheWorld Health Organization (WHO) recommends consuming at least 400 grams of fruits and vegetables per day to reduce the risk of noncommunicable diseases, including lifestyle-related diseases. Polyphenols are one of the most representative functional components found in fruits and vegetables. Polyphenols are a general term for plant-derived compounds containing phenolic hydroxyl groups, which contribute to bitterness, color, and astringency; it is said that over 8,000 types exist in nature. While many studies have demonstrated the efficacy of polyphenols in humans, many have low bioavailability, and there are still many unknowns regarding their mechanisms of action. This phenomenon is known as the “polyphenol paradox.”

Once polyphenols reach the large intestine, they undergo extensive metabolism by gut bacteria and are broken down into low-molecular-weight phenolic compounds. Diverse polyphenols, such as tannins and flavonoids, are metabolized into C6-C1, C6-C2, C6-C3, and C6-C3 dihydro compounds. When gut bacteria metabolize polyphenols such as chlorogenic acid found in coffee, hesperidin found in citrus fruits like oranges, γ-oryzanol found in rice bran, and curcumin found in turmeric, HMPA—a C6-C3 dihydro compound—is consistently detected. In vitro studies suggest that HMPA possesses a wide range of functionalities, including antioxidant, anti-inflammatory, glucose transport-enhancing, platelet activation-inhibiting, vascular endothelial protective, melanin production-inhibiting, and hair growth-promoting effects. In vivo studies have reported its ability to suppress weight gain, improve lipid metabolism, provide neuroprotection, and inhibit muscle atrophy. Even polyphenols with low bioavailability may be broken down into smaller molecules by gut bacteria and contribute to functional expression as gut bacterial metabolites of polyphenols.

In this presentation, we will introduce the relationship between diet, gut bacteria, and HMPA, as well as the effects confirmed in human clinical trials, including the suppression of postprandial blood glucose levels, reduction of waist circumference, and reduction of LDL cholesterol. We are also currently conducting HMPA research utilizing large-scale health screening data. Reports quantifying HMPA concentrations in human blood are scarce, and there are no examples of large-scale investigations into its relationship with diet and health. While “diet” was traditionally defined as the intake of nutrients and functional components, the understanding is shifting toward recognizing the complex relationship among three elements: humans, food, and gut bacteria. Moving forward, we intend to advance research on the significance and importance of functional gut bacterial metabolites.

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The Efficacy of HMPA on Cognitive Function

Rikiya Shiwaku

Maruzen Pharmaceutical Co., Ltd. Research Institute

Since the World Health Organization (WHO) introduced the concept of “healthy life expectancy (HALE)” in 2000, attention has shifted from merely extending “life expectancy”—which measures the length of survival—to extending “healthy life expectancy,” which emphasizes physical and mental function and quality of life (QOL). In Japan as well, since the formulation of “Healthy Japan 21 (First Plan)” by the Ministry of Health, Labour and Welfare in the same year, extending healthy life expectancy has been positioned as a primary goal, continuing through to the current Third Plan. It is known that, in addition to metabolic syndrome and locomotive syndrome, cognitive decline significantly contributes to factors that hinder healthy life expectancy, and prevention and improvement through daily exercise and diet are recommended for all of these factors.

In our previous research, we have found that 3-(4-hydroxy-3-methoxyphenyl) propionic acid (hereinafter HMPA), whichis commonly metabolized from multiple polyphenols by gut bacteria, possesses various physiological effects. Regarding cognitive function, we have confirmed that in central nervous system glial cells (astrocytes), HMPA promotes the expression of aquaporin 4, which is involved in the removal of waste products from the brain, as well as TGF-β and IL-10, which are anti-inflammatory cytokines in the brain.However, no studies had previously evaluated the effects of HMPA on cognitive function in humans. Therefore, we are verifying the effects of HMPA on cognitive function through human clinical trials, and in this presentation, we will introduce the details of that research.

To investigate the effects of HMPA on cognitive function, we conducted a randomized, double-blind, controlled trial involving healthy adult men and women aged 65 to 79 years. Participants were instructed to continuously consume 100 mg of rice bran fermentate containing 23 mg of HMPA for 24 weeks and to perform light exercise. The light exercise consisted of seated knee extension exercises, which are recommended as a measure against frailty, and cognitive function was assessed using Cognitrax. The results showed a reduction in reaction time after 24 weeks, suggesting that HMPA, when combined with light exercise, contributes to improving reaction time, which is a component of cognitive function in older adults. Reaction time is a function exemplified by “quickly responding to traffic signs” or “responding in a timely manner during conversations with others,” and can be considered a cognitive function directly linked to quality of life (QOL), such as the maintenance of daily life and social activities. Based on these findings, we have even greater expectations for HMPA as a food ingredient that can help extend healthy life expectancy.

The English translation was prepared by Maruzen Pharmaceuticals Co.,Ltd.

HMPA Analysis Techniques for Foods

Hiroaki Kawamoto

Maruzen Pharmaceutical Co., Ltd. Research Institute

It has been 10 years since “Foods with Function Claims” was launched, and to date, more than 10,000 products have been submitted and approved. Functional foods are approved not only in supplement form but also in a variety of food formats, such as beverages, confectionery, and prepared foods, and consumers are increasingly encountering them on store shelves. Under this system, food businesses are responsible for claiming functional properties based on scientific evidence, and since the system’s inception, quantitative testing has been mandatory to confirm that products intended for notification contain the functional ingredients. Consequently, the importance of quantitative and qualitative testing of the final product has increased significantly due to the diversification of functional ingredients and product forms.

In this presentation, we report on the high stability of HMPA (3-(4-hydroxy-3-methoxyphenyl)propionic acid) based on test results conducted under various conditions, including heating in aqueous solution, light irradiation, and adsorption by packaging materials. High-performance liquid chromatography (HPLC) is primarily used for the quantitative and qualitative analysis of HMPA, and when no impurities are present, analysis using a standard C18 column is generally sufficient. However, it has been found that when the product takes the form of a food item, such as a clear liquid, components contained in other ingredients can interfere with and inhibit the analysis. Therefore, quantitative and qualitative analyses are currently being performed using a PBr column. Using the PBr column analysis method, five-point calibration curves were created for standard solutions (1–100 μg/mL), yielding a coefficient of determination ($R^2 = 0.999999$) and excellent linearity. Furthermore, quantitative tests were performed by a third-party institution on two lots of powdered formulations, tablets, and granules, and the error relative to Maruzen Pharmaceutical Co., Ltd. was within 2%, indicating good agreement.

Furthermore, this presentation will explainthe rationale behind the changes to the analytical conditions and will present analytical results from the addition of HMPA to various food products, such as yogurt, cookies, and chocolate, given that HMPA has virtually no effect on taste or aroma and is expected to be suitable for incorporation into a wide range of food forms.

Currently, the number of approved functional food products using HMPA as a functional ingredient has exceeded 130, and the food forms are extremely diverse. However, there are infinite combinations of ingredients that can be incorporated into foods, and it is expected that some combinations may hinder quantitative and qualitative testing in ways that have not yet been identified. To resolve such issues, further improvements in analytical technology will be required in the future.