

FOODLAB

INTERNATIONAL

FOOD ANALYTICS + FOOD SAFETY | FOOD PROCESSING + AUTOMATION
FUNCTIONAL FOODS + INGREDIENTS | LEGISLATION + LABELING

1 2026
MARCH

By clicking
on the ad
you will
receive
further
information



FT-NIR SPECTROSCOPY

FOOD ANALYSIS SOLUTIONS



FT-NIR solutions for safe processes, highest product quality, and sustainable production.



Quality begins with precise analysis. We support food manufacturers in ensuring safety and efficiency along the entire value chain: from raw materials to the final product.

Visit us at Analytica 2026 in Munich, Germany – Booth A2.314

www.food-analysis-nir.com

Innovation with Integrity

- 2 Content/Imprint/Advertising Companies
- 3 Editorial: 15 Years of FOOD-Lab and eFOOD-Lab International

AI

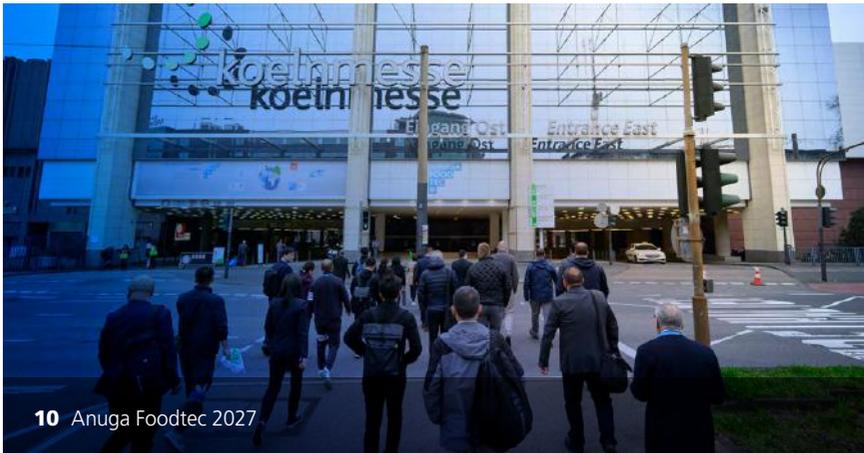
- 6 The future eats data – why AI will only advance the food industry if the data is right
– Arne Kröger, Gutzmann Software, Lübeck
- 8 Knowledge as a production booster – Paul Weber, Dr Lukas Oehm, Fraunhofer IVV Dresden

Global Food and Water Management

- 12 Global Dietary Shift: More Prosperity Does Not Automatically Mean Increased Consumption of Animal Products – Prof. Chr. Fischer, University Bolzano, IT
- 14 Global Forum for Food and agriculture: sustainable water useage
- 15 Raising the profile of what we drink – and eat: Improving the analysis of amino acids by an automatic pre-column derivatization method – Natsuki Iwata, Vadim Kraft, Shimadzu

Future Trade Fairs

- 10 Anuga Foodtec 2027



10 Anuga Foodtec 2027



15 Raising the profile of what we drink – and eat: Improving the analysis of amino acids by an automatic pre-column derivatization method

Advertising Companies:

▸ 2mag AG ▸ Behr Labor-Technik GmbH ▸ Bruker ▸ Shimadzu Europa GmbH

eFOOD-Lab

International Trade journal for the international food and related suppliers' industry
www.food-lab-int.com

Contact:

info@mcongressconsult.de
Cell phone: +49(0) 152/33 92 43 47

Publisher:

mcongressconsult
In der Wehrhecke 30
D-53125 Bonn
Cell phone: +49(0) 152/33 92 43 47
E-mail: info@mcongressconsult.de

Editorial Staff:

Thomas Kützemeier
Cell phone: +49(0) 152/33 92 43 47
E-mail: info@mcongressconsult.de

Graphics & Layout:

Janz Design
Nikolai Janz
Mittelstraße 86
40721 Hilden
E-mail: nj@janz.design
www.janz.design

Advertising Sales Office:

mcongressconsult
In der Wehrhecke 30
D-53125 Bonn
Cell phone: +49(0) 152/33 92 43 47
E-mail: info@mcongressconsult.de

Bank Details:

Volksbank RheinAhrEifel eG
IBAN: DE 10 57761591 0159 62 05 00
BIC.: GENODED1BNA

Place of Payment and Jurisdiction:
Bad Breisig/Germany

All rights reserved.



15 Years of FOOD-Lab and eFOOD-Lab International

**Climate Change. Resource Management.
Digitalization/AI.**

My first FOOD-Lab interview partner in 2011 was the extreme mountaineer and organic farmer Reinhold Messner, who lives in South Tyrol. He spoke about how, with increasing warming and the melting of the glaciers whose ice "glues" the mountains together, the mountains will break apart. The recent rockfalls in Blatten, Valais, in 2025 show the direction things are heading. Nevertheless, the people in the village want to rebuild everything.

Messner stated that wherever glacial meltwater has previously provided fertile soil and sufficient drinking water, such as in Asia, Europe, and Latin and North America, water shortages will occur. We now know that glacial melt initially creates the illusion of a higher available water supply in valleys due to meltwater runoff, leading to serious long-term drought damage. Sustainable global water management was therefore the central theme of the Global Forum for Food and Agriculture (GFFA), held in Berlin during the Green Week in January.

He also predicted that, thanks to the increasing warming temperatures on his organic apple farm and throughout South Tyrol's fruit-growing region, it would be possible to cultivate earlier, new, and climate-resilient varieties with healthier ingredients, thus generating competitive advantages. Fruit Logistica, held in the Italian Hall of the Berlin trade fair in February, showcased the fruits of such efforts, as did Biofach in Nuremberg.

Of particular analytical interest at Fruit Logistica was the US manufacturer Felix Instruments, which develops portable, non-destructive measuring devices for analyzing fruit quality and gases. These devices are used worldwide by growers, packing plants, and researchers to measure parameters such as ethylene, Brix, and dry matter in fruit. Validating ethylene control systems doesn't have to be slow or complicated. The presentation demonstrated how real-time ethyl-

MAGNETIC STIRRERS

- 100% wear- and maintenance-free
- Submersible and heat resistant
- Durable and sustainable
- 3 years warranty
- Made in Germany





Interview with Reinhold Messner for the first issue of FOOD Lab in 2011

ene monitoring replaces the manual effort of conventional testing methods and how live data confirms the performance of the ethylene reduction technologies used.

From Klagenfurt, Austria, the company avemoy came to Berlin with its HORTI-SCAN drone system – a fully automated drone and AI system for greenhouses – and won an innovation award. Autonomously flying drones capture high-resolution image data, detect stress factors early on, and support targeted measures for higher yields and better quality.

An important topic at Analytica at the end of March in Munich will be the analysis of microplastics in the environment, says Prof. Wagner. Microplastics originate from, among other things, food packaging. Pyrolysis followed by gas chromatography and mass spectrometry is arguably the gold standard of mass-based methods, alongside FTIR or X-ray microscopy. However, detection remains a challenge. Therefore, the focus will also be on packaging optimization for the food industry to further minimize residues.

Interpack takes place in Düsseldorf in May. Three of the 18 exhibition halls are dedicated specifically to process and packaging technology for confectionery and baked goods, showcasing how manufacturers are responding to new consumer habits, changing recipes, and increasing sustainability requirements.

From November 10th to 12th, 2026, BrauBeviale, under the motto "All Beverages. One Future.", will offer insights into the development of new market perspectives and product offerings – such as for the growing segment of non-alcoholic beer in the brewing sector. In addition, other beverage segments will be expanded: In the upcoming trade fair package for 2026 and 2027, organizer YON-TEX will focus particularly on the production of non-alcoholic soft drinks.

Professor Christian Fischer of the University of Bolzano has determined in a study that increasing prosperity does not automatically lead to ever-increasing meat consumption and that the methane emissions, which are undesirable for the climate, still offer potential for influencing animal feed and husbandry practices.

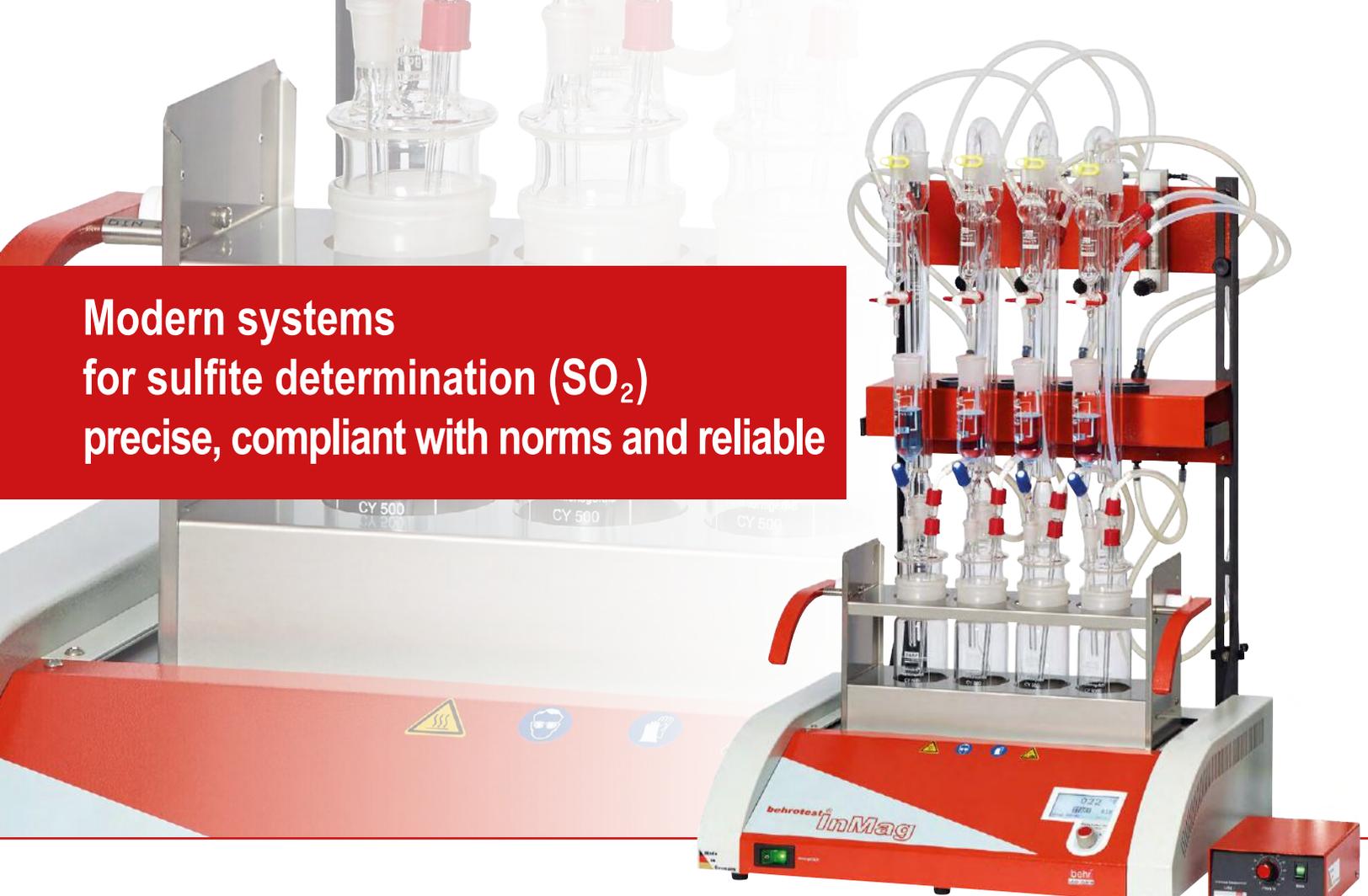
Finally, we take a look ahead to Anuga Food-Tec 2027 in Cologne. AFT manager Roland Thiemann tells us that the early bird registration period has ended very successfully. However, there are still places available. Anyone considering attending should hurry.

I hope you enjoy the read!.



Thomas Kützemeier

publisher and editor-in-chief
phone: +49 (0) 152/33 92 43 47
email: info@mcongressconsult.de



**Modern systems
for sulfite determination (SO₂)
precise, compliant with norms and reliable**

Our devices enable the precise determination of total sulfite in accordance with DIN EN 1185 and DIN EN 1988-1 (Monier-Williams method), ideal for routine analysis and demanding quality controls.

- Available with 1, 4, or 6 sample positions — maximum flexibility for every laboratory.
- Integrated magnetic stirrer, precise heating and flow control for maximum measurement stability.
- Reliable sulfite distillation with high repeatability and reproducible results.
- Ideal for professional food analysis and reliable assessment of sulfite content in food and beverages.

Your reliable solution for precise sulfite analysis.

behr Labor-Technik GmbH • Spangerstraße 8 • 40599 Düsseldorf/Germany
Tel.: (+49) (0) 211 – 7 48 47 17 • eMail: info@behr-labor.com
Internet: www.behr-labor.com



behr
Labor-Technik

See for yourself and visit us in Munich from March 24 to 27.

March 24–27, 2026
Messe München

Visit us ▶

Hall A1
Booth 104



analytica



The FUTURE *eats data*



Author: **Arne Kröger**, CEO Gutzmann GmbH, kontakt@gutzmann.com, Tel: 0451/203320, www.gutzmann.com

Artificial intelligence has made enormous strides in recent years. For the food industry, this opens up opportunities along the entire value chain: from quality control and process optimization to product development. At the same time, the technological understanding of AI in the market has evolved. While image recognition and automation were often considered typical AI applications in the past, today Large Language Models (LLMs) are the main topic of discussion because they communicate directly with people and seemingly "understand" what is being asked. But regardless of how impressive modern AI models may appear, their usefulness depends entirely on the quality of the data on which they are based. This connection is particularly important in an industry where safety, traceability, and precision are essential.

AI systems like Large Language Models don't operate with understanding in the human sense. They calculate statistical probabilities for which word or word fragment (so-called tokens) is likely to appear next. This principle impressively explains why they

Why Artificial Intelligence Will Only Advance the Food Industry If the Data Is Right

appear astonishingly precise in some cases and completely wrong in others. LLMs are just one subfield of modern AI: While image models can detect physical defects and predictive models can optimize production lines, LLMs focus on language—and thus on processes like knowledge retrieval, documentation, communication, and decision support. Simple, consistently worded questions lead to consistent, but not necessarily "correct" answers—simply because certain formulations occurred more frequently in the training data than others. The models therefore generate plausible language, but not verified knowledge. This becomes particularly clear in seemingly simple examples: If, for instance, you ask "Pick a number between 1 and 50" in a new conversation in the current version of ChatGPT, the answer is always "27" - not because this would be mathematically meaningful, but because this string has a high

probability of appearing at this position in the LLM's training data.

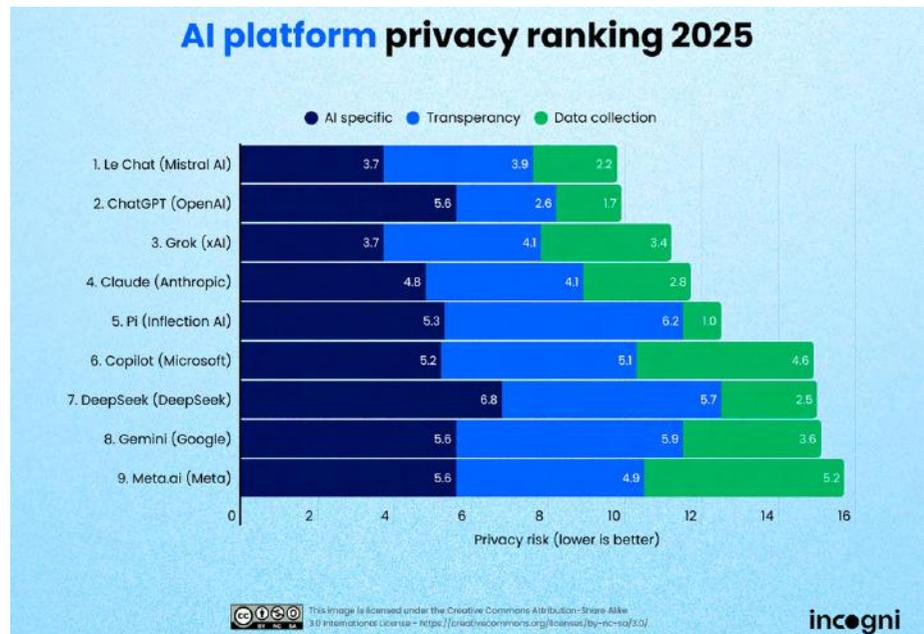
The problem with this method becomes particularly clear when it comes to so-called hallucinations: answers presented confidently but factually incorrect. A recent study by the European Broadcasting Union ("News Integrity in AI Assistants: An international PSM study," October 2025) illustrates the extent of the issue: 45 percent of the AI answers examined contained at least one significant error, and 81 percent exhibited some form of factual inconsistency. The causes range from outdated information and weak sources to a lack of context or unclear distinctions between fact and opinion. In practice, this means that AI can appear convincing even if the answer is factually incorrect, incomplete, or entirely fabricated. Added to this are typical problems such as altered or invented quotes, inappropriate sources like satire sites,

or misunderstandings caused by suggestive prompts. This can pose a problem for companies—especially where decisions or analyses are based on such results or where processes are to be automated.

Many of these weaknesses are directly related to the data. If information is incomplete, poorly structured, or outdated, models resort to patterns that seem plausible to them—even if they are incorrect. Hallucination is therefore not a "fault" in the technical sense, but the logical consequence of statistical prediction logic without verification. Conversely, the better the underlying data, the more reliably the system behaves. For the food industry, this means that data quality is not just a technical detail, but a key success factor in any AI strategy. This includes not only quantities and structures, but also variance (i.e., the ability to represent both standard and exceptional cases) and timeliness—a crucial point in a market characterized by fluctuating commodity prices, new regulations, and changing consumer needs. Companies that fail to maintain their data risk investing "blindly" in AI projects that may later disappoint or even pose risks.

Against this backdrop, the question often arises whether companies should develop their own AI models. For most, this isn't necessary. LLMs are generalists who excel at many tasks—but don't possess in-depth expertise in every industry. Far more crucial is selecting a suitable model and the ability to feed it with relevant, well-maintained company data. Modern methods like Retrieval-Augmented Generation (RAG) make it possible to selectively integrate information from internal sources—without having to retrain the model itself. This methodical context enrichment can drastically reduce the error rate, sometimes to single-digit percentages. At the same time, this is the fastest, lowest-risk, and most cost-effective way to deploy a model in a business-specific manner. While an in-house model would require expensive infrastructure, training, legal reviews, and long-term maintenance, a RAG system can often be deployed productively within a few weeks.

In parallel, standards are emerging to simplify the integration of AI into existing systems. The Model Context Protocol (MCP) approach, for example, aims to describe existing software solutions in a way that allows AI models to interact with them more easily. Instead of having to program individual integrations between systems, interfac-



Source: Incogni Blog

es, or machines, software vendors or open-source providers will in the future deliver machine-readable descriptions that AI models can understand and use. For an industry that often works with specialized machines, customized ERP systems, and complex supply chains, this can significantly accelerate the development of practical AI applications. This creates a kind of "interaction language" that standardizes AI-based automation and reduces dependence on individual integration projects.

Another aspect is increasingly coming into focus: data protection and data sovereignty. Many AI providers use user-generated content—prompts—for their own training or share it with partners. An analysis by the data protection company Incogni ("Gen AI and LLM Data Privacy Ranking 2025," published in summer 2025) shows that while opt-out options exist, they do not function transparently or reliably on all platforms. Furthermore, data already available online—for example, from social media—often cannot be excluded from training processes. For companies working with sensitive information such as recipes, production parameters, or supplier relationships, careful review is essential. In some cases, using open-source models can be beneficial because they can be operated locally, thus offering significantly greater control over one's own data. However, they also come with limitations—such as reduced functionality or additional licensing terms. Furthermore, companies must ensure that the license actually permits commercial use, does not violate any pro-

hibited uses, and in which areas fine-tuning remains legally permissible.

Ultimately, the benefits of AI in the food industry are clear: better forecasts, more efficient processes, more precise analyses, and faster innovation cycles. At the same time, it's evident that projects can fail if they launch without a solid data foundation or if people within the company aren't sufficiently involved. AI transforms workflows—and this only works if employees recognize the added value and trust the system. Conversely, if fears dominate—for example, due to unclear communication, unrealistic expectations, or poor results from inaccurate data—the use of AI can even create chaos. The risk is that valuable working time will be lost, incorrect decisions will be made, or teams will resist new technologies. Successful AI projects therefore always consider people as part of the system—human-in-the-loop is a crucial success factor.

That the future will be data-driven is beyond question. The crucial question is whether companies use their existing data in a way that ensures AI not only promises new opportunities but actually creates added value. Those who structure, maintain, and utilize their information lay the foundation for a technologically robust and, at the same time, responsible development of the food industry. Only those who understand what data they possess, how they can use it, and where the risks lie will be able to actively shape this future instead of merely reacting to it.

The future consumes data – and it demands good ingredients.

Knowledge as a production booster

Efficiency and resilience through AI-supported knowledge management



Authors: **Paul Weber** and **Dr. Lukas Oehm**

Efficient and resilient production depends less on the latest generation of machines than on whether crucial knowledge is available at the right moment. Whether it's responding

quickly to an unplanned machine downtime, setting the right machine parameters when quality deviations occur, or efficiently coordinating format changes – in practice, experience often determines success

or stagnation. However, this experiential knowledge is tied to individual people in many food production companies.

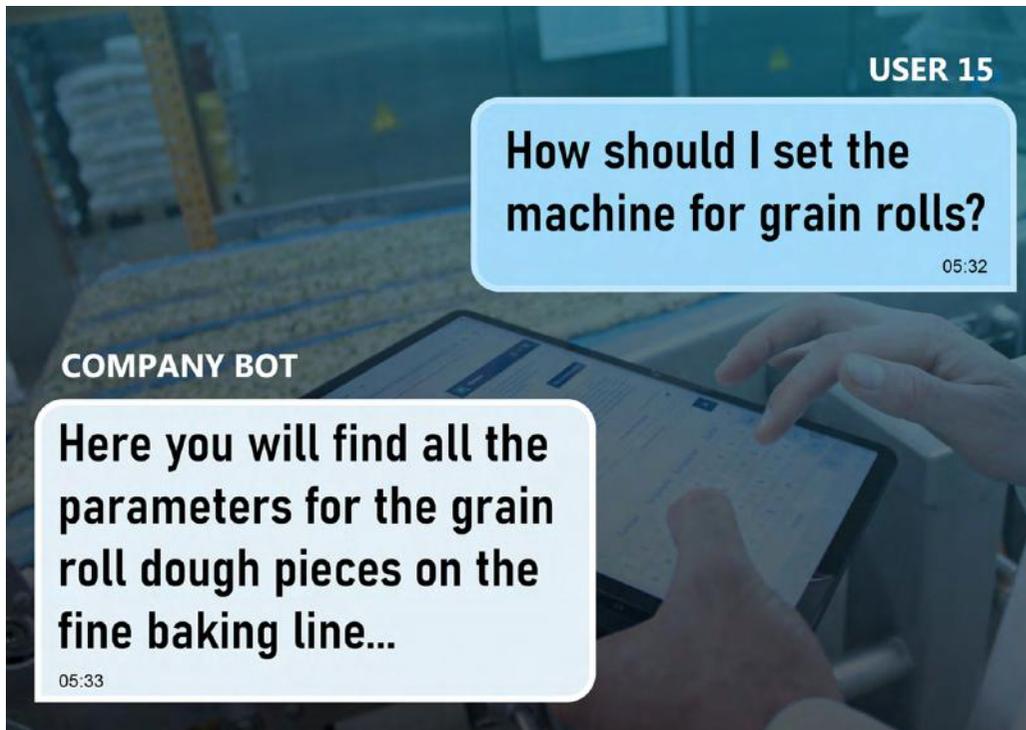
Machine operators, shift supervisors and team leaders with years of practical experience have a deep understanding of the equipment, processes and products. They recognise connections where others only see symptoms and know which adjustments to make in specific cases. This dependency becomes problematic when these individuals are unavailable – whether due to illness, holiday or leaving the company. The shortage of skilled workers further exacerbates the situation. As a result, companies are increasingly faced with the challenge of not only preserving critical production knowledge, but also making it accessible to all relevant employees at all times. Knowledge management thus becomes a central building block for efficiency, resilience and sustainability.



Knowledge capture plays an increasingly important role in ensuring efficient production. (©Fraunhofer IVV)

AI as a door opener for corporate knowledge

In the wake of the current AI boom, AI-powered chatbots are increasingly coming into focus. Systems such as ChatGPT,



USER 15

How should I set the machine for grain rolls?

05:32

COMPANY BOT

Here you will find all the parameters for the grain roll dough pieces on the fine baking line...

05:33

An internal company chatbot provides secure knowledge for operators. (@Fraunhofer IVV)

Perplexity and Gemini are capable of summarising and classifying information from large training databases and publicly accessible Internet sources and providing it in natural language. However, these systems quickly reach their limits when used in production: internal company documents, specific technical terms, and machine- or product-specific empirical values are not taken into account – even though they are crucial to production success.

An AI system for internal company knowledge

This is where the knowledge management system developed by the Fraunhofer Institute for Process Engineering and Packaging IVV in collaboration with Hallo Welt! GmbH comes in. The aim was to make verified internal company knowledge available in such a way that it can be easily accessed via an AI chatbot in a context-specific manner.

The technological basis is Semantic MediaWiki, a wiki system that structurally links knowledge content and systematically classifies it in its technical context. At its heart is a formal ontology that describes typical relationships in craft-based food production and can be flexibly expanded to include company-specific details.

The AI chatbot accesses both the ontology and the wiki content. It interprets the information contained therein and

can process queries in natural language. When production staff ask a question, the chatbot checks which technical and company-specific content is relevant to it and incorporates this specifically into its response. This results in practical, reliable and subject-specific answers. The inclusion of the systematic knowledge base also significantly reduces the risk of hallucinations.

Another key aspect is the continuous maintenance of the knowledge base. Existing content can be updated and new content can be systematically added. Experienced users are supported in this process by structured input.

Practical test in a bakery

The structured recording methodology was tested in a demonstration project with the Möbius GmbH & Co. KG bakery. In collaboration with experienced production staff at the medium-sized company, specific knowledge content and relevant knowledge relationships were identified, which were directly incorporated into the adaptation of the ontology and thus into the system. 'This knowledge, which is currently completely unstructured in many people's minds, can also be put into a systematic form,' said Mathias Möbius, managing director of the bakery, after the workshops.

The knowledge management system enables the structured collection, processing and provision of critical pro-

duction knowledge. It can be operated cloud-based or on-premises; with a local installation in particular, the knowledge remains within the company.

The benefit lies in making companies less dependent on individual experienced employees and making production more robust. Experienced employees are not replaced, but rather relieved of specific tasks. They can concentrate on their core tasks instead of having to constantly intervene as problem solvers. Matthias Möbius is convinced that 'this basic approach could be of interest to many companies.'

Are you also dependent on personal knowledge and the experience of individual employees in your production? Contact us to learn more about the implementation.

→ www.ivv.fraunhofer.de

The authors

Paul Weber is a research associate at the Fraunhofer IVV and is doing his doctorate on the topic of systematic knowledge representation to ensure production efficiency in food production. **Dr. Lukas Oehm** is deputy head of the Cyber-Physical Processing and Cleaning Systems department at the Fraunhofer IVV in Dresden.



„Navigate Complexity. Smart. Safe. Sustainable.“

Anuga FoodTec 2027 introduces its new key theme

Photo: Koelnmesse

Under the key theme of "Navigate Complexity. Smart. Safe. Sustainable.", Anuga FoodTec is showing how the food and beverage industries can master complexity and accelerate innovations from 23 to 26 February 2027. This transformation is characterised by global flows of commodities, changed consumer behaviour and climate protection, while the requirements for quality, safety, traceability and efficiency accompanied by sustained cost pressures are increasing at the same time.

The key theme stands for solutions that combine efficiency and safety with ecological, economic and social responsibility – networked, automated, digital and resource-conserving.

"With its key theme of 'Navigate Complexity. Smart. Safe. Sustainable.', Anuga FoodTec 2027 points out possibilities for how data-supported control, secure networking and resource-efficient processes can make complexity in pro-

duction manageable", explains Roland Thiemann, Director of Anuga FoodTec.

Specialised programme in cooperation with the DLG

In order to reinforce the content orientation of the top theme, Anuga FoodTec 2027 is working together closely with the German Agricultural Society (DLG), which contributes its scientific and practical expertise to the shaping of the specialised programme. "As the specialist partner and industry sponsor of Anuga FoodTec 2027, we are developing the specialised programme for the top theme and networking leading experts from science, industry, politics and practice", explains Carola K. Herbst, Deputy Managing Director/Food & Food Technology Division Manager of the DLG. "Our ambition is to provide trade visitors with well-founded analyses, concrete recommendations for action and practical solutions that show how technological innovations can be strategically

and holistically integrated into complex production processes."

Navigate Complexity: Three building blocks of the technological future

The Smart, Safe and Sustainable building blocks translate the key theme into practice and mark the most important technological fields of activity for the food production of tomorrow.

Smart: AI-supported, automated and digital systems create transparency, flexibility and efficiency – from raw materials management to intralogistics – and support data-based decisions.

Safe: Process and cybersecurity, hygiene control, monitoring and gap-free traceability secure quality standards and make it possible to manage risks.

Sustainable: Resource optimisation, energy efficiency and circular approaches anchor sustainability as an integral element of modern value creation.

The next events:

ISM und ISM Ingredients

The world's largest trade fair for confectionery, snacks, and their ingredients

Cologne 01.02. - 04.02.2026

ProSweets Cologne

The international supplier fair for the sweets and snacks industry

Cologne 01.02. - 04.02.2026

THAIFEX – HOREC Asia

Southeast Asia's leading Hospitality & Food Service Trade Show

Bangkok 11.03. - 13.03.2026

Anuga FoodTec 2027: International platform for innovation and technology

As a global industry meeting point, Anuga FoodTec networks experts from industry, science and politics and provides orientation in a dynamic market environment. As a provider of impulses for the transformation of the global F&B industries, it brings together the international food tech network to advance solutions, strategies and innovations along the entire value creation chain and for all branches of the food and beverage industries – One for All. All in One. Technology is thus presented in a lively way at Anuga FoodTec, treated with a practical orientation and made visible across the entire process breadth. In addition to this, the trade fair also provides clear impulses for the continuing development of food production with its new key theme.

The next **Anuga FoodTec** is taking place from **23 to 26 February 2027** in Cologne.

Koelnmesse – industry trade fairs for the food technology sector

Koelnmesse is an international leader in organising trade fairs in the field of food and beverage processing. Anuga FoodTec and ProSweets Cologne are established, world-leading trade fairs, hosted in Cologne/Germany. In addition to the events at its Cologne headquarters, Koelnmesse also stages further food technology trade fairs with different sector-specific areas of focus and content in key markets across the world, including India, Italy and Colombia. These global activities enable Koelnmesse to offer its customers bespoke events and leading regional trade fairs in a variety of markets, thus creating the foundation for sustainable international business. Koelnmesse is also ideally positioned in the field of food and beverages with its leading international trade fairs Anuga and ISM and its global network of satellite events.



Global Dietary Shift

More Prosperity Does Not Automatically Mean Increased Consumption of Animal Products



Author: **Christian Fischer**, Chair of Agricultural and Food Economics, Free University of Bozen-Bolzano, Italy

A recent study by my research group investigates whether global diets are becoming increasingly animal-based in the long term, i.e., whether people worldwide are consuming more and more animal-based foods. This question is of central importance for the sustainability of food supply systems, as animal-based foods are generally associated with higher resource and energy consumption as well as higher greenhouse gas emissions than plant-based products. Therefore, a diet that relies more heavily on animal products is considered less sustainable than a more plant-based diet.

We used data from international sources, including global dietary surveys (FAO Food Balance Sheets) and World Bank national income indicators (gross domestic product per capita), to analyze long-term trends in consumption patterns. The study aimed to examine the development of the share of animal calories in total calorie consumption and the trophic level of the average global human diet in order to draw conclusions about the sustainability of global dietary patterns.

The trophic level indicates the position of a diet in the food pyramid, which can be measured on a scale from 1 (primary food producers) to 5 (large carnivores). Human diets can be described using the human trophic level (HTL). The HTL measures the

energy intensity of the dietary composition and reflects the relative proportion of plant-based versus animal-based products in the human diet. Higher HTL values indicate a diet rich in energy-intensive animal products. The current global average HTL for human diets is around 2.2, reflecting an omnivorous diet. Higher HTL values (above 2.5) indicate a meat-based (carnivorous) diet, while lower values (~2.0) suggest a plant-based (vegetarian or vegan) diet.

Empirical Approach

Instead of limiting ourselves to short periods, we were able to construct an analytical timeframe of approximately 250 years. This reconstruction made it possible to visualize dietary trends over long periods by combining historical developments in different income groups across countries. We assumed that different income groups reflect different stages of economic development and thus different time intervals. By presenting successive income groups side by side, we can gain a long-term perspective on the past. The validity of this approach rests on the assumption that dietary change processes in the analyzed countries are largely comparable. Given the potential heterogeneity of cultural, institutional, demographic, and agroecological conditions, this assumption may only be partially fulfilled. Accordingly, this reconstruction should be interpreted as

an analytical construct rather than a literal historical development, which may contain limitations and distortions.

Dietary trends are described using two key indicators:

- The **proportion of calories from animal sources** (ASC) in total calorie consumption (e.g., those from meat, milk, eggs, fish).
- The **trophic level** (HTL) value, which, as described, indicates how heavily a diet relies on higher-energy foods (such as meat) compared to plant-based foods.

The research effort involved merging different data sets and methodically considering structural changes over decades. This allowed for a clearer identification of general trends.

Results

Our analysis shows that in wealthier countries, the proportion of calories from animal-based foods has not increased significantly since around the 1980s. Prior to that, a marked increase was observed, which was associated with rising income. The fact that this proportion has stagnated in wealthier societies means that the additional consumption of animal products does not increase indefinitely with rising wealth. In lower-income countries, the proportion of animal-based calories continues to rise, but

the global average is not moving towards a continuously increasing trend. Similar to the calorie proportion, trophic levels also show a stabilizing trend rather than a continuous increase. A higher trophic level is an indicator of a predominantly animal-based diet, but the data suggest that a global shift to very meat-heavy diets is unlikely.

The key finding from our analysis is that, given historical and current trends, the proportion of animal calories in total calorie intake (ASC) is unlikely to increase significantly beyond a global average ASC of 30% (Figure 1). This aligns with the EAT-Lancet Planetary Health Diet recommendation, which states that animal calories should comprise 27% of total calorie intake to ensure adequate micronutrient intake (without additional fortification or supplementation) for adults. Regarding HTL values, while the global average has increased over the past few decades, our results indicate it may never reach 2.5 (the starting point for carnivorous diets) (Figure 2). The results are consistent with other studies on dietary trends and changes, which show that meat consumption in industrialized countries has reached a plateau or is growing only slowly. In many of these countries, the calorie intake from animal sources will no longer increase significantly, even if incomes continue to rise.

An important reason for this is that with increasing prosperity, not only is more income available, but dietary preferences, lifestyles, health awareness, and sensitivity to environmental issues also change. These factors can contribute to the fact that people do not automatically consume more animal products at a certain level of prosperity.

Conclusion

The research shows that the global dietary trend is not necessarily heading towards a heavily meat-based diet in the long term. While the consumption of animal calories and corresponding trophic levels increased in high-income countries in the past, the long-term trend in recent decades indicates stagnation or at least a clear cap on further increases.

Thus, the frequently expressed concern that the world's diet will increasingly include more animal products at the expense of sustainability and environmental resources is not empirically confirmed. Instead, the available data suggest that stabilization effects will set in

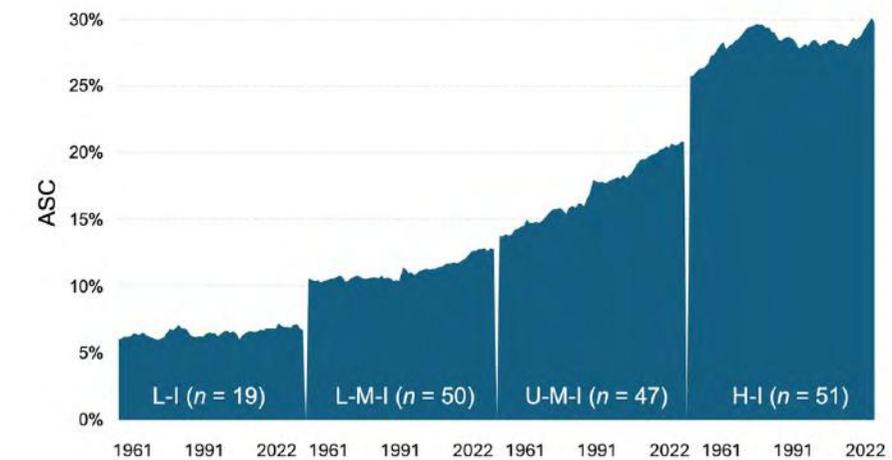


Figure 1

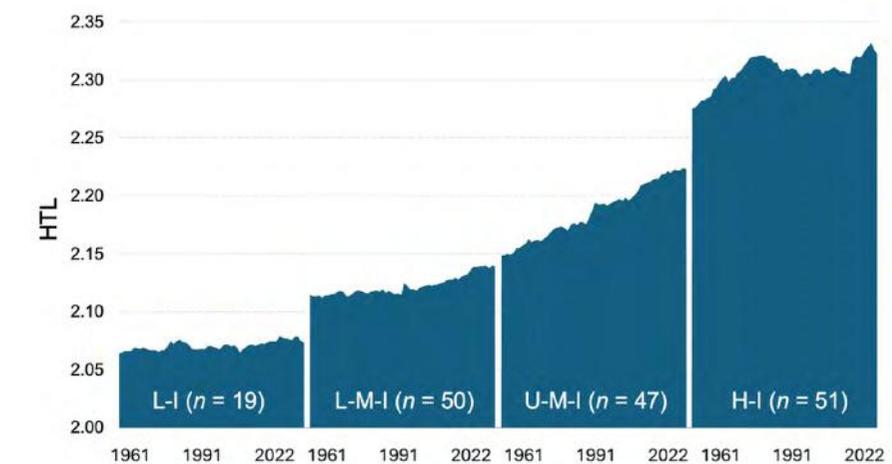


Figure 2

The development of the animal calorie share of total human calorie intake (ASC) and the development of human trophic levels (HTL) from 1991 to 2022 in different income groups (L-I: low per capita income, L-M-I: low to medium per capita income, U-M-I: medium to high per capita income, H-I: high per capita income). "n" is the number of countries in each income group.

before an "extremely meat-based global dietary pattern" is reached.

It has also been shown that greenhouse gas emissions from animal-based foods vary considerably due to production factors such as feed conversion, land use, and manure disposal practices. This fact presents a significant reduction potential through the wider adoption of climate-friendly practices in livestock farming. Furthermore, technological advancements could enable a further reduction of methane emissions from ruminants by up to 20% through improved animal and feed management, feed composition, and rumen manipulation. Therefore, a medium-term transition to low-carbon livestock farming appears feasible.

For policymakers, nutritionists, and sustainability researchers, this finding

means that strategies to promote healthy and environmentally friendly diets should not assume that all countries will inevitably move towards very high levels of animal consumption. Rather, it should be considered that socioeconomic, cultural, and educational factors are crucial – and that promoting sustainable dietary patterns often depends more on contextualized policies and educational strategies than on continuous income growth.

Reference

Kipkoech B., Ruto E. and Fischer C. (2026). *Global diet not likely to become carnivorous as animal-source calorie consumption shares and human trophic levels stabilize in the long run. Frontiers in Sustainable Food Systems, Vol. 10, No. 1727309. DOI: 10.3389/fsufs.2026.1727309*



Global Forum for Food and Agriculture (GFFA)

during the International Green Week Berlin, 16./17.01.2026

Nourish and Flourish: Sustainable Water Use in Agriculture for Feeding 10 Billion People on a Livable Planet

by Th. Kützemeier

More than 2000 people from around the globe gathered during this year's GFFA meeting in a frosty Berlin. The problems with water scarcity are well known around the planet, not so much in our western hemisphere but the more intensive in Africa and Asia.

By 2050, our planet will need to feed nearly 10 billion people, but current agricultural water management (AWM) practices can only sustainably ensure food for 3.4 billion. This gap highlights the urgent need to transform water management in agriculture. AWM is fragmented and infrastructure-driven, overlooking inefficiencies, institutional weaknesses, and ecological limits. This leads to overuse in some regions, underuse in others, and risks to food security, rural livelihoods, and ecosystems.

The session under the competent lead of the World Bank has shown how transformative AWM can deliver food security while enabling climate resilience and environmental stewardship. The keynote by Dr Poolad Karimi presented insights from the World Bank's upcoming report, "Nourish and Flourish", which includes a new water-food nexus typology, three paradigm shifts for AWM, and the "Prosperity-People-Planet" framework. P. Karimi holds the position of a Senior Irrigation

Specialist and Head of Global Water Informatics at World Bank.

The session has highlighted innovations like AI-driven remote sensing, digital water platforms and performance-based irrigation contracts. The private sector – especially smallholders and technology providers – play a key role. Panelists have discussed combining green and blue water resources to boost productivity and protect ecosystems.

Emphasis was on scaling climate-resilient irrigation, integrating AWM into broader land, water, energy and agricultural strategies, and building inclusive, sustainable pathways. Case studies were used to illustrate lessons, point out existing gaps and showcase opportunities for collaboration. The session ended with a dialogue on mobilising investment, strengthening institutions, and building partnerships for a transformative global AWM agenda.



Dr Poolad Karimi

While western countries in Europe, the U.S.,-Canada and Russia were hit by massive snowfalls in January/February, others were flooded with ever-high water levels like in Queensland, Australia. Some people still believe that climate change is just something ordinary. It sounds as if the European Scientific Advisory Board ESABCC has surrendered fighting climate change these days. The leading scientific institution demands stronger efforts to protect citizens against weather extrema. In its latest report it warns the EC should be aware of an average temperature increase of 2.8-3.3 degrees C by the end of the millennium. According to the UN Intergovernmental Panel on Climate Change (IPCC) the temperature will increase by 2.8 degrees if the (moderate) fight against climate change continues unchanged. However, in the view of the World Meteorological Organisation (WMO), Europe is a continental hotspot i.e. it will see a 2.4 rise if the rest of the world is experiencing 1.4 to 1.5 degrees. If the overall increase of the planet average temperature reaches a peak of 2.8 then Europe will suffer under an increase of nearly 4.0 degrees C. Bearing in mind the floods, droughts and fires in 2021 under the current climate changes one may imagine what the resulting extreme events could be like in the years to come.

Raising the profile of what we drink – and eat

Improving the analysis of amino acids by an automatic pre-column derivatization method



Authors: **Natsuki Iwata**, Shimadzu Corporation, **Vadim Kraft**, Shimadzu Europa GmbH

Testing food and drink for safety, authenticity, quality and nutritional content is vital to maintaining public health, consumer confidence and business success. A recent proof-of-concept experiment on alcoholic beverages confirmed a streamlined new method for amino-acid assessment that is applicable to other food and drink as well. The method delivers increased accuracy while reducing testing runtimes by up to half.

We've all seen the stories: the 100 % ground beef that contained horsemeat, the fake fruit juice, the expensive branded whisky that was counterfeit, the adulterated honey. Or the 2009 scandal where melamine was added to milk and infant formula to make them appear richer in protein ... and which tragically led to illness and death.

The safety and quality of the things we eat and drink is such a foundational concept of modern life that we often take it for granted. And we assume that what the label claims – about ingredients or nutritional content – is an accurate reflection of the actual contents. Most of the time, all is well. We have laws, regulations, ethical practices and professionals of various kinds who together ensure that consumers know what they are getting, and that it is safe for them to con-

sume. And, because science and technology are always improving, regulations are constantly updated, and responsible businesses adapt to meet those ever-higher standards.

Food and beverage testing helps ensure that regulatory standards are met. Amino-acid testing is one of more sophisticated tools that scientists use to check the quality, safety and authenticity of what we eat and drink, as well as to assess the quantities of various components – protein, for example – for trustworthy nutritional labeling. Amino-acid assessment provides reliable identification – a sophisticated fingerprint – that reveals whether a food product contains what it is supposed to. Inferior, dangerous or simply incorrect ingredients or even the improper mixture of the right ingredients can be accurately identified by amino-acid

testing and helps to support health, business success and consumer contentment.

Natsuki Iwata works in Kyoto, Japan, and is an expert in the field of amino-acid testing using high-performance liquid chromatography (HPLC), with numerous related patents, awards and publications. She recently conducted an experiment using amino-acid profiling on alcoholic beverages.

Amino acids and their uses

Amino acids exist as two mirror-image forms, known as D- and L-enantiomers. While L-amino acids are most abundant in biological systems, D-amino acids have recently garnered interest for their effects on food taste, preservation and their emerging role as disease biomarkers.^[1] D-amino acids offer distinctive fla-

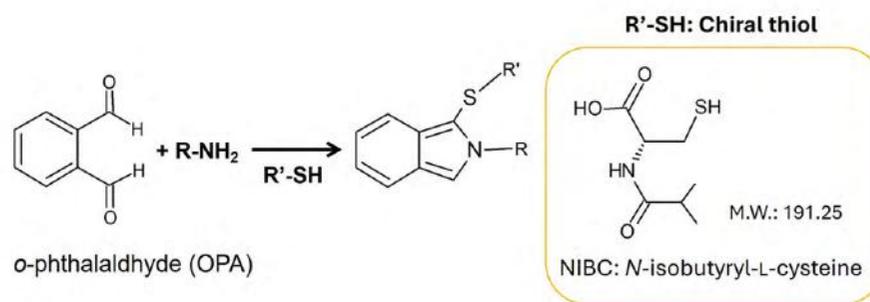
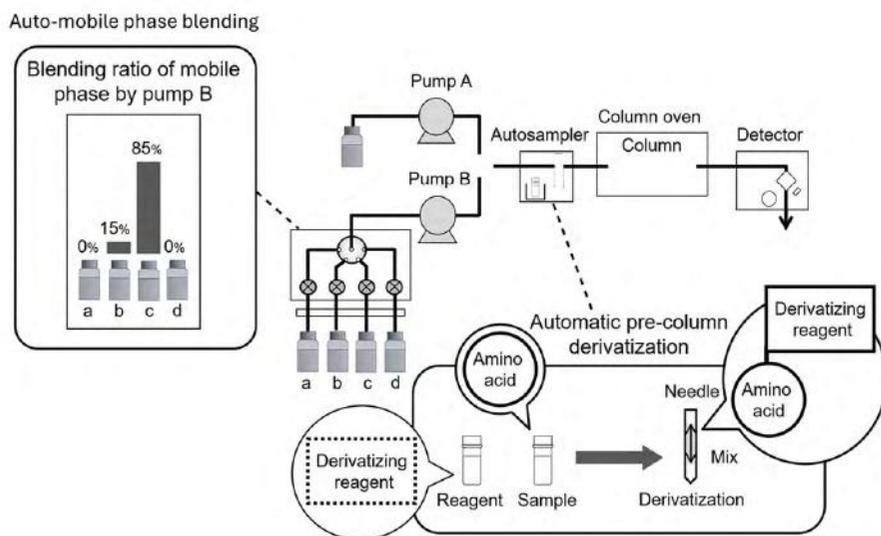


Figure 1: OPA fluorescence derivatization

Table 1: Preparation of derivatizing reagent

1	OPA reagent Add 0.3 mL of ethanol into 10 mg of o-phthalaldehyde and dissolve completely. Then add 0.7 mL of 0.1 mol/L borate buffer (pH 9.1) and 4 mL of ultra-pure water.
2	NIBC solution Add 10 mg of N-isobutyryl-L-cysteine into 10 mL of 0.1 mol/L borate buffer (pH 9.1).
3	OPA/NIBC solution Mix equal volume of OPA reagent and NIBC solution.

**Figure 2: Flow diagram of automated HPLC setup**

vor characteristics compared to their L-forms; for example, D-leucine and D-phenylalanine impart a sweet flavor, while the corresponding L-forms are perceived as bitter. The specific balance of D- and L-amino acids in foods contributes to the overall complexity of taste.

Once considered biologically inactive, D-amino acids have also now been shown to play specific physiological roles in humans and other organisms, such as supporting gut health and influencing metabolism, though research in this area is ongoing. The ratio of D- to L-amino acids in foods is also useful for evaluating processing techniques and product authenticity, particularly in fermented or aged foods.

Accurately separating and measuring D- and L-amino acids is therefore important – increasingly so – in food science and clinical applications. But traditional analysis methods such as liquid chromatography-mass spectrometry (LC-MS) and multi-dimensional HPLC have limitations. LC-MS may be affected by sample matrix complexities, for instance, and multi-dimensional systems can be time-consuming and complicated to operate. So there is a clear need for analytical

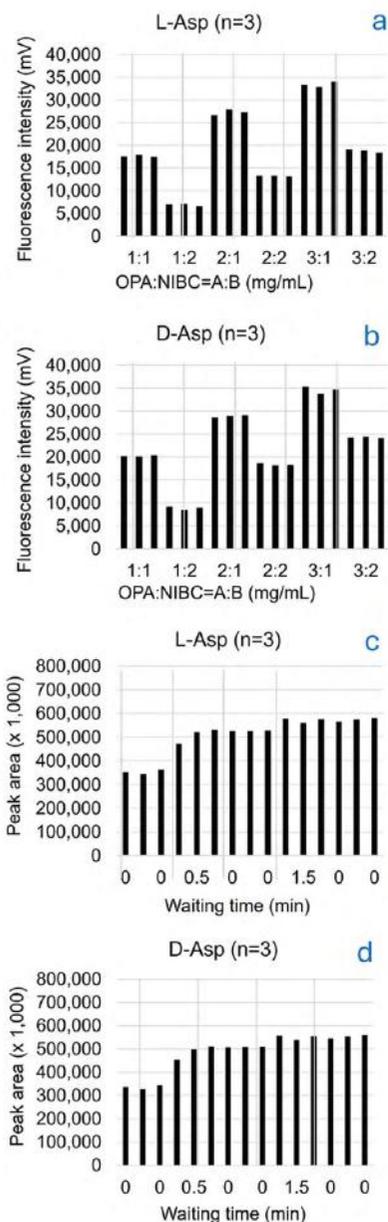
techniques that are fast, straightforward and reliable for D/L-amino acid quantification.

The method investigated in Natsuki Iwata's study was based on a derivatization reaction of o-phthalaldehyde (OPA) and the chiral thiol N-isobutyryl-L-cysteine (NIBC), followed by analysis using liquid chromatography. The pioneering work in this area was done by Euerby et al. in the late 1980s.^[2-7] In those studies, different chiral thiols were synthesized and investigated after manual derivatization with OPA on a reverse phase of HPLC allowing the separation of D- and L-enantiomers of several amino acids.

Can better technology lead to better methods?

Acutely aware of the great evolution in liquid chromatography in recent years, Natsuki Iwata reasoned that state-of-the-art UHPLC (Ultra HPLC) instruments should enable fully automatic derivatization and highly efficient separation of compounds. So that is what she set out to test.

Two kinds of beer (beer A and B), sake, red wine and white wine were used as samples.

**Figure 3: Optimization of OPA: NIBC ratio and reaction time**

Beer A and beer B were ale type (top fermenting) and lager type (bottom fermenting), respectively. Beer A, beer B, red wine and white wine were diluted ten-fold (twenty-fold for sake) with 10 mmol/L hydrochloric acid and then passed through 0.2 µm PTFE membrane filters.

Careful preparation is essential

Fluorescence derivatization of the diastereomers was performed by the reaction with OPA under NIBC conditions. A standard (Shimadzu) UHPLC instrument equipped with a fluorescence detector was used for determination of 37 D/L-amino acids (Figure 2), and the eMSTAT – Shimadzu's Easy Mass Spectrometric Statistical Solution – was applied for principal component analysis (PCA). The

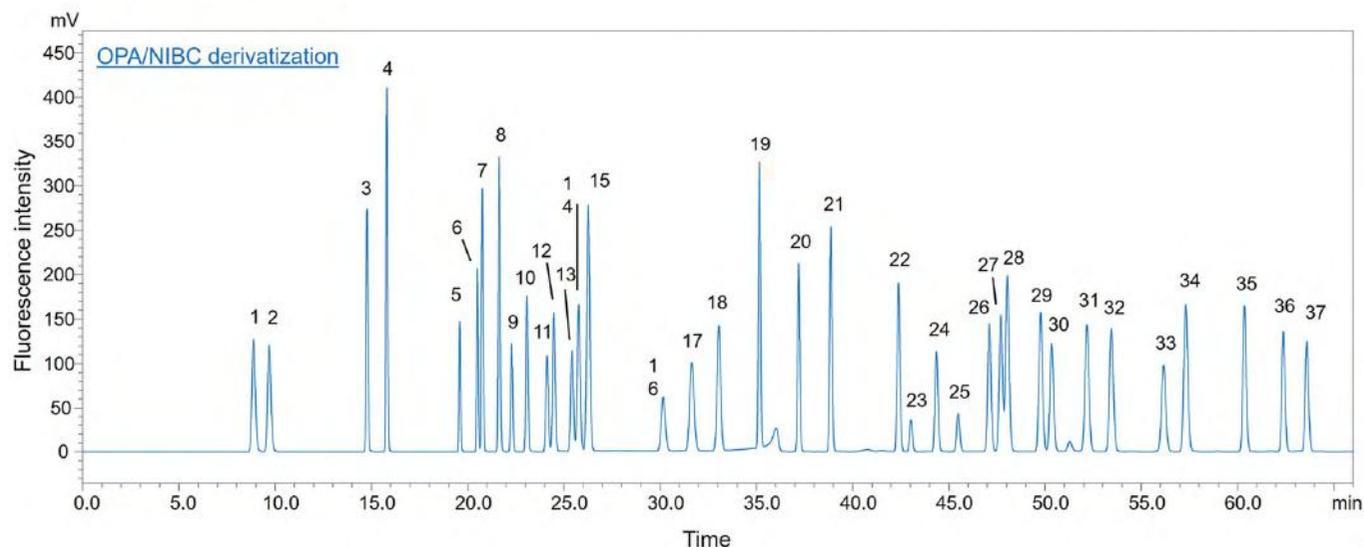


Figure 4: Chromatograms of a standard solution of D/L-amino acids (5 µmol/L each)

analytical conditions are presented in Table 2. Tables 1 and 3 show the details to the preparation of the reagents and the derivatization procedure of the autosampler.

The optimum combination in concentration of the OPA reagent and NIBC solution was examined using a standard solution of D/L-amino acids (1 µmol/L each). Six combinations of varying concentrations were investigated. The fluorescence intensities of D/L-Asp raised with increasing OPA concentration in a constant NIBC concentration. On the other hand, the fluorescence intensities of D/L-Asp decreased with increasing NIBC concentration in constant OPA concentration. The combination of 3 mg/mL for OPA and 1 mg/mL for NIBC elevated the column back pressure, possibly due to clogging. Therefore, the combination of 2 mg/mL for OPA and 1 mg/mL for NIBC was adopted as the optimum concentration (Figure 3a and 3b).

To promote the derivatization reaction and obtain good repeatability, a constant waiting

time after mixing the OPA/NIBC solution and the sample within the injection needle of the autosampler was introduced into the pretreatment program. Five different waiting times were examined in advance. As the peak area was constant after 1.5 minutes or more, the waiting time was set to 1.5 minutes (Figure 3c and 3d).

Putting the method to the test: Analysis of a standard solution of 37 D/L-amino acids

A previously reported method with two switching conditions required an analysis time of 120 minutes per sample^[8]. In that method, two chiral thiols of N-acetyl-L-cysteine (NAC) and NIBC were independently applied for the reactions. Their products with amino acids were separated and the results from both chromatograms were combined, with a total analysis time of 60 minutes each.

For her work, however, Natsuki Iwata decided to use NIBC alone for the reac-

tion. By increasing the methanol ratio in the mobile phase, setting the column temperature to 20 °C and separation on a unique column, it was possible to separate all 37 diastereomers of D- and L-amino acids in a single analysis within just 66 minutes (Figure 4), cutting overall analysis time almost in half. An overview of the separated amino acids is provided in Table 4. Table 5 shows the description of abbreviations of amino acids.

Validating the method

The relative standard deviations (%RSD, n = 6) of the peak areas for a standard mixture of D/L-amino acids (0.1 µmol/L each) were 1.6 % or less, indicating excellent repeatability. This high level of consistency was achieved through the automatic pre-column derivatization, which ensured a constant derivatization time. Calibration curves for all 37 D/L-amino acids demonstrated good linearity, with coefficients of determination (r^2) of 0.999 or higher. For recovery testing, beer B was selected and spiked with a standard solution containing 31 D/L-amino acids. The final concentration was set to 1 µmol/L for most

Table 2: Analytical conditions

System	NexeraTM X3
Column	CERI L-column3 C18 (150 mm x 2.1 mm I.D., 2.0 µm) using pre-column filter
Flow rate	0.22 mL/min
Mobile phase	[Pump A] 10 mmol/L (sodium) phosphate buffer (pH 6.9) [Pump B] B) Acetonitrile, C) Methanol B/C = 15:85 using mobile phase blending function
Time program	Gradient elution
Column temp.	20 °C
Injection volume	1 µL
Detection	FL Ex: 338 nm, Em: 455 nm

Table 3: Automatic pre-column derivatization

1	OPA/NIBC solution 2 µL
2	Sample 1 µL
3	Mix
4	Wait 1.5 minutes
5	Injection

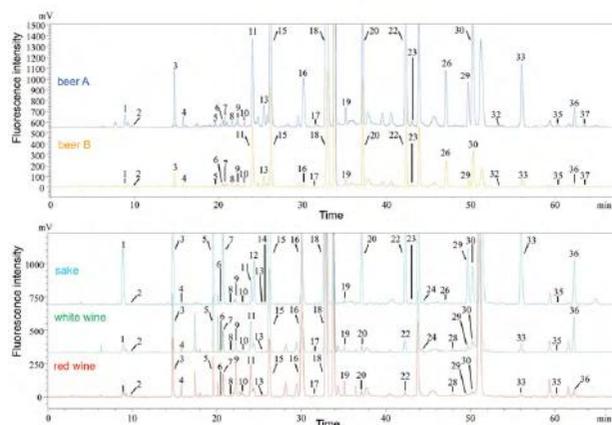


Figure 5: Chromatograms of OPA/NIBC-derivatized diastereomers in alcoholic beverage

amino acids. Six amino acids were instead adjusted to a final concentration of 10 $\mu\text{mol/L}$ each. The six samples were simultaneously pretreated following the established pretreatment protocol. The recovery rates ranged from 84.9 % to 108.6 %, with %RSD values between 0.8 % and 9.5 %, demonstrating the method's reliability and accuracy.

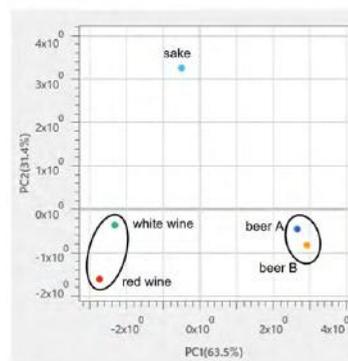
Applying the method to alcoholic beverages

As shown in Figure 5, 25 to 28 amino acids were separated and detected in five samples.

Table 4: Target compounds

1	L-Asp	20	L-Tyr
2	D-Asp	21	D-Tyr
3	L-Glu	22	L-Val
4	D-Glu	23	L-(Cys) ₂
5	L-Asn	24	L-Met
6	D-Asn	25	D-(Cys) ₂
7	L-Ser	26	L-Trp
8	D-Ser	27	D-Met
9	L-Gln	28	D-Val
10	D-Gln	29	L-Ile
11	L-His	30	L-Phe
12	L-Thr	31	D-Trp
13	D-His	32	D-Phe
14	D-Thr	33	L-Leu
15	Gly	34	D-Ile
16	L-Arg	35	D-Leu
17	D-Arg	36	L-Lys
18	L-Ala	37	D-Lys
19	D-Ala		

(a) Score plot



(b) Loading plot

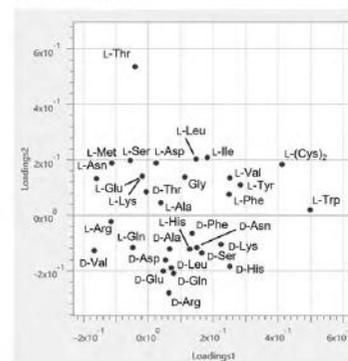


Figure 6: Results of the PCA (n = 4)

The overall ratio of D-amino acid to D/L-amino acid (%D) was found to be 6 % or less in all samples. The determination results of D/L abundance ratios of specific amino acids were close to those of the previous studies, using HPLC^[9] and GC-MS^[10] for various real-sample analyses. For details to quantification results, refer to publication.

A PCA was performed using the content of each compound (n = 4) in beverages (Figure 6). As a result of the PCA, beer A and beer B were plotted close together on the score plot as well as red and white wines. It was

also found that sake showed different characteristics from these beverages. The loading plot revealed that the two kinds of beer as well as the red and white wines contained many D-isomers, while the sake was rich in L-isomers. In particular, L-Trp, D-His and D-Lys contributed significantly to the two kinds of beer, D-Val to the red and white wines and L-Thr to the sake. This suggested that the first principal component (PC1) showed differences in the types of beverages, while the second principal component (PC2) revealed differences in the isomers.

Table 5: Description of abbreviations

Asp	Aspartic acid
Glu	Glutamic acid
Asn	Asparagine
Ser	Serine
Gln	Glutamine
His	Histidine
Thr	Threonine
Gly	Glycine
Arg	Arginine
Ala	Alanine
Tyr	Tyrosine
Val	Valine
(Cys)2	Cystine
Met	Methionine
Trp	Tryptophan
Ile	Isoleucine
Phe	Phenylalanine
Leu	Leucine
Lys	Lysine

References

- [1] Iwata, N., Kobayashi, M. (2024). *Chromatography*. 45 (2): 63–72.
- [2] Euerby, M.R., Partridge, L.Z., Gibbons, W.A. (1989). *Journal of Chromatography A*. 483: 239–252.
- [3] Euerby, M.R., Partridge, L.Z., Rajani, P. (1988). *Journal of Chromatography A*. 447: 392–397.
- [4] Euerby, M.R., Nunn, P.B., Partridge, L.Z. (1989). *Journal of Chromatography A*. 466: 407–414.
- [5] Euerby, M.R., Partridge, L. Z., Nunn, P.B. (1989). *Journal of Chromatography A*. 469: 412–419.
- [6] Euerby, M.R. (1988). *Journal of Chromatography A*. 454: 398–405.
- [7] Euerby, M.R., Partridge, L.Z., Gibbons, W.A. (1988). *Journal of Chromatography A*. 445: 433–440.
- [8] Iwata, N., Watabe, Y., Horie, S., Hayakawa, Y. (2021). *Chromatography*. 42: 133–141.
- [9] Jin, D., Miyahara, T., Oe, T., Toyōka, T. (1999). *Anal. Biochem.* 269: 124–132.
- [10] Ali, H.S., Pätzold, R., Brückner, H. (2010). *Amino Acids*. 38: 951–958.



Detecting heavy metal with confidence

The Shimadzu ALTRACE makes elemental analysis faster, easier, and more reliable than ever before. With industry-leading sensitivity and the ability to handle 48 samples in one run, it delivers results in minutes – without complicated preparation. This benchtop EDXRF system simply works, ensuring confidence in every element.

Ultra-trace detection (sub ppm Cd, Pb)

Measures heavy metals directly, from trace levels to several percent

High throughput (48 samples per run)

Sample racks can be exchanged during measurement for continuous operation

Fast, simple, cost-efficient

Non-destructive results in minutes, with minimal running costs and no complex prep



Visit us at A1.501

