eFOODLAB INTERNATIONAL

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

2 2026 JUNE

4 HPLC methods for identifying and quantifying sugars and organic acids in tonic water and gin

12 Small-portion powder products as value drivers: Why packaging suitability is already decided in the mixing process

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

Contact:
info@mcongressconsult.de
Phone: +49 (0) 2 28/20 94 99 24

Publisher:
mcongressconsult
In der Wehrhecke 30
D-53125 Bonn
Direct line: +49 (0) 228/20 94 99 24
E-mail: info@mcongressconsult.de

Editorial Staff:
Thomas Kützemeier
Direct line: +49 (0) 228/20 94 99 24
Cell phone: +49 (0) 152/33 92 43 47
E-mail: info@mcongressconsult.de

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

Advertising Sales Office:
mcongressconsult
In der Wehrhecke 30
D-53125 Bonn
Direct line: +49 (0) 228/20 94 99 24
E-mail: info@mcongressconsult.de

Eric C. Martienssen, Cologne
Phone: +49 (0) 221/739 19 29
Cell phone: +49 (0) 173/951 17 77
Mail: eric.martienssen@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

Nutritional Trends, AI, and Connectivity from farm to fork

Data-driven high-tech agriculture isn't entirely new, but the food industry needs to engage more deeply with this topic, said Peter Schellekens at Fruit Logistica 2026 in Berlin in February. The Dutchman specializes in combining advanced agricultural technologies and food processing, with a strong focus on robotics, data-driven production systems, and value chain integration. Through his work, he connects leading companies, technology developers, and research institutes, and actively shapes innovation programs in the Dutch and European agricultural and food sectors. FOOD-Lab showcases the latest developments in the field of highly integrated food chains.

Prof. Rainer Barnekow, OWL, spoke at the Fresenius Farm Managers' Conference in March about small-portion powder products as value drivers. Advanced mixing technologies play a key role.

Another focus of this FOOD-Lab 2-2026 is on the long-standing trend of plant-based alternatives to meat products. Godo Röben, former marketing director of Rügenwalder Mühle and current consultant to numerous companies, demonstrated at the 20th Trend Day of the FoodRegio Association for Schleswig-Holstein in Lübeck how he and his company managed to achieve market leadership despite considerable internal and external resistance, and what lessons can be learned from this success story.

Dr. Brigitte Bollig of Shimadzu Europe provided an overview of the analytical strategies currently available for reliably analyzing ingredients such as sugars and organic acids using the latest HPLC technology, using tonic water as an example. Precise analysis of these components can provide insights into the factors that influence the taste and quality of a gin and tonic.

I hope you enjoy reading this.

Best regards

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

The perfect taste where sweet meets sour

HPLC methods for identifying and quantifying sugars and organic acids in tonic water and gin

Author: **Dr. Brigitte Bollig**, Shimadzu Europa GmbH

This article provides a detailed description of the application of HPLC analysis for determining sugars and organic acids – in tonic water especially. By analyzing these components in detail, insight into the factors that influence the taste and quality of a gin and tonic can be gained.

The gin and tonic: a refreshing beverage with a history as long as the glass it's served in [1] that's hugely popular across the world. Sales of tonic water, which is also enjoyed neat, are just as high: One market analysis company estimated the global market at USD 1.29 billion in 2024, and this is anticipated to rise to USD 1.85 billion within five years,[2] with the largest growth expected in the Asia-Pacific region.

Product developers at beverage companies are always coming up with new flavors in the hope that they will appeal to consumers' tastes: For example, the market analysts highlight the varieties of "Raspberry Rhubarb", "Wild Elderflower" and "Damask Rose", some of which are made with dandelion instead of quinine.[2]

Once the tonic water of choice is placed in the shopping cart and later in the refrigerator, then it's traditionally mixed with gin: Gin and tonic – the combination of gin, a distilled alcoholic beverage mainly characterized by its juniper note, and tonic water, a carbonated drink with a bitter edge – owes its unique taste to a variety of chemical components. Sugar and organic acids are some of these chemical components that play a significant role since they contribute to the taste profile and sensory experience of the beverage to a large extent. This text shows analysis methods for certain components of tonic water and gin samples, important for manufacturers, test laboratories and consumer protection companies. Precise measuring procedures are necessary to ensure that consumers get a tasty and safe beverage.

Determination of sugars

Sugars are essential ingredients in many drinks, as they not only provide sweetness but also bring a balance to the various flavor components. Gin and tonic can contain different types of sugar such as glucose, fructose and sucrose, each of which has varying levels of sweetness and sensory properties. These sugars not only affect the taste but also the texture and the mouthfeel of the drink. The exact composition and concentration of the sugars can be precisely determined using

analytical methods such as high-performance liquid chromatography (HPLC).

In nine of the ten tonic water samples that were tested, sucrose was declared as the sweetener. Only one tonic water gets its sweetness from a combination of fructose and stevia.

Sucrose, also known as granulated sugar, is a disaccharide made up of equal parts of the monosaccharides fructose and glucose. As a result of the low pH value in the tonic water, the sucrose is hydrolyzed into the monosaccharides. That's why only the monosaccharides fructose and glucose are determined for quantifying sugars in tonic water, the sum of which giving the sucrose content.

The chromatographic determination of sugars presents two challenges. On the one hand, saccharides cannot be separated using conventional reversed-phase HPLC due to their high polarity, and on the other hand, sugars do not have any chromophoric groups, which is why it's not possible to detect them using UV-Vis.

However, a good alternative to chromatographic reversed-phase separation of sugars is HILIC (hydrophilic interaction chromatography). A polar column with typical reversed-phase solvents such as acetonitrile and water is used for this. The elution strength of the solvents is reversed compared to traditional reversed-phase chromatography. In HILIC, water is the stronger solvent for the elution of substances from the column compared to acetonitrile. The column material mostly consists of modified polymers, and the column material used here is a polymer with functional amino groups.

The RID-20A refractive index detector from Shimadzu is used as an alternative to a UV-Vis detector. This works based on the change in the refractive index between the pure liquid and the analyte. The exact analysis conditions are laid out in Table 1.

Standard and sample preparation

To quantify fructose and glucose, solutions in the concentration range 0.25–1.25 mg/mL and 0.25–1.0 mg/mL respectively were prepared in the mobile phase (Figure 1). The sample solutions were diluted with the mobile phase at a ratio of 1:50.

Results of the sugar determination

The calibration curves of the sugars that were tested, fructose and glucose, are

System	Nexera-i
Column	Shodex HILICpak VG-50 4E (4.6 mm x 250 mm)
Guard column	Shodex HILICpak VG-50G 4A (4.6 mm x 10 mm)
Flow rate	1 mL/min
Mobile phase	Water/Acetonitrile 20/80
Column temperature	40 °C
Injection volume	5 µl
Detection	RID-20A (Refractive Index Detection)
Run time	12 minutes

Table 1: Analytical conditions for the determination of sugars

Tonic water	Glucose [g/100 mL]	Fructose [g/100 mL]	Sucrose (calculated) [g/100 mL]
1	3.7	4.5	8.2
2	3.3	3.9	7.1
3	3.4	4.1	7.4
4	–	4.3	–
5	3.2	3.8	7.1
6	4.1	4.8	8.8
7	3.3	4.0	7.3
8	4.0	4.8	8.7
9	3.9	4.7	8.6
10	3.9	4.8	8.7

Table 2: Results of the sugar determination in ten tonic water samples

very good with a regression value of $R2 > 0.999$ (Figures 2 and 3).

In the nine tonic waters that were declared as containing sucrose, this was also found in the stated quantity. The results all turned out very similar and range between 7.1 and 8.8 g of sucrose per 100 mL tonic water (Figure 4 and Table 2). The tonic water that was sweetened only with fructose contains the same amount of fructose as the other nine tonic waters. These were all sweetened with sucrose, which means they also contain glucose. The lack of sweetness from not using glucose in that tonic water was compensated for by adding stevia instead (content according to LC-MS analysis: 0.1 mg/mL).

Neither fructose nor glucose could be detected in the gin samples.

Organic acids

Organic acids provide the sour taste and freshness of the drink and can regulate the sensation of sweetness and bitterness. The organic acids usually found in gin and tonic are citric acid, malic acid and ascorbic acid. These acids are not only important when it comes to the taste but also play a role in the stability and shelf life of the drink. HPLC analysis makes it possible to precisely deter-

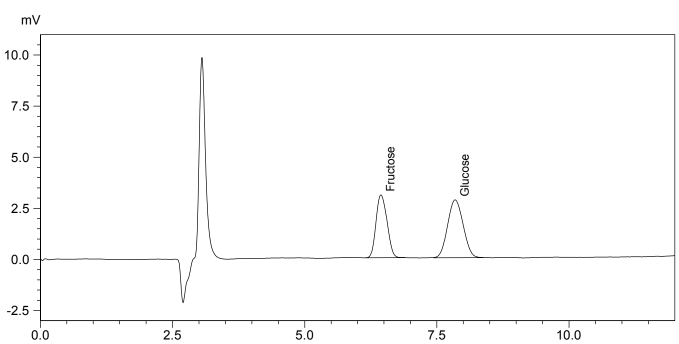


Figure 1: Chromatogram of a reference standard for sugar determination

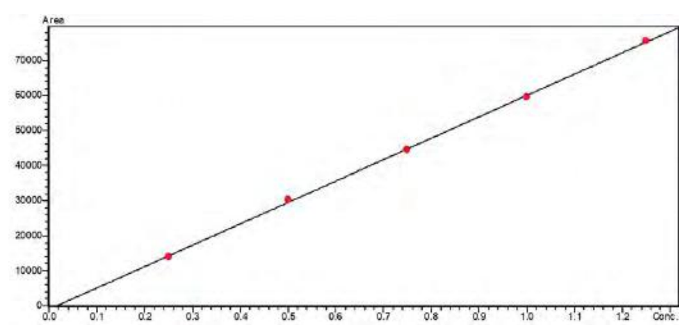


Figure 2: Calibration for fructose 0.25–1.25 mg/mL

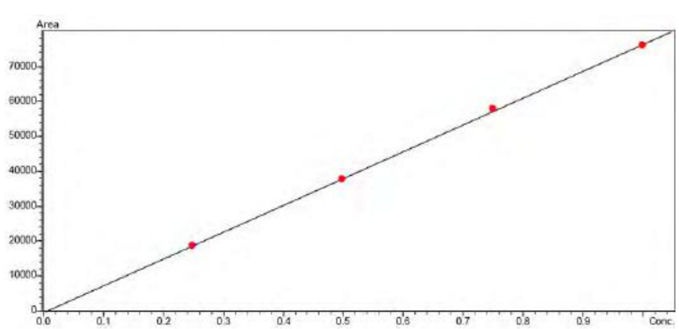


Figure 3: Calibration for glucose 0.25–1.0 mg/mL

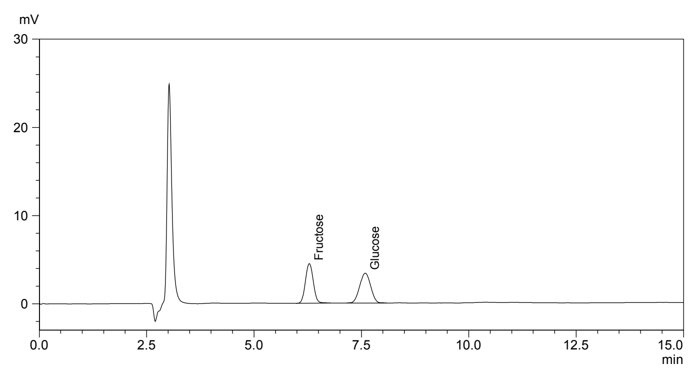


Figure 4: Chromatogram of a tonic water sample for sugar determination

mine the concentrations of these acids in samples of tonic water and non-alcoholic gins.

Citric acid was found in all ten tonic water samples tested. This is an organic tricarboxylic acid that belongs to the group of fruit acids. Citric acid fulfills several functions in tonic water, including changing the taste and lowering the pH value, which then reduces the growth of microorganisms.

In two tonic waters, ascorbic acid and malic acid were declared in addition to citric acid. Ascorbic acid is used as an antioxidant in food.

Organic acids are highly hydrophilic compounds that are difficult to determine with the C18 columns often used in HPLC analysis. The disadvantage of organic acids in UV detection is that they only absorb in the non-selective low wavelength range, which can lead to contamination caused by impurities and the absorption of solvents. That's why ingenuity is needed both when it comes to choosing a solvent and a column and for the detection method in order to perform analyses with high levels of sensitivity and selectivity.

The Nexera organic acids analysis system uses "post-column pH buffering with electrical conductivity detection". Organic acids are separated by ion exclusion chromatography with an acidic solvent and then mixed with a pH-buffering reagent to increase detection sensitivity (Figure 5). The system is optimized for the analysis of organic acids, and since the retention times are very stable, it's also possible to provide a qualitative estimation of the organic acids contained in unknown samples.

Standard and sample preparation

As the concentration ranges of the organic acids were not known, screening was carried out with all gins and tonic waters. The samples were injected without dilution for this. The acids and concentrations identified in the screening were then used to create calibration curves for quantification (Table 3).

Results of the determination of organic acids

Calibration curves were created for citric acid and malic acid in the range of 1.0–5.0 mg/mL. The calibration curves of

System	Nexera Organic Acid Analysis System
Column	2 x Shim-pack SCR-102H (300 mm × 8.0 mm I.D., 7 µm)
Guard column	Shim-pack SCR-102H (50 mm × 6.0 mm I.D.)
Flow rate	0.8 mL/min
Mobile Phase	5 mmol/L p-toluene sulfonic acid
pH buffer reagent	5 mmol/L p-toluene sulfonic acid
20 mmol/L bis-tris	5 µl
1 mmol/L EDTA	RID-20A (Brechungsindex-Detektion)
Column temperature	40 °C
Injection volume	10 µL
Detection	CDD (Conductivity Detection)

Table 3: Analytical conditions for the determination of organic acids

Tonic Water	Citric acid [g/100 mL]	Ascorbic acid [g/10 0mL]	Malic acid [g/100 mL]	Acetic acid [g/100 mL]
1	3.9	declared but not found	–	found but not declared, approx. 0.1 mg/mL
2	3.9	–	–	–
3	3.8	–	–	–
4	5.0	–	–	–
5	3.3	–	1.0	–
6	4.4	–	–	–
7	3.9	–	–	–
8	4.2	–	–	–
9	3.9	–	–	–
10	3.9	–	–	–

Table 4: Results of the determination of organic acids in ten tonic water samples

Alcohol-free Gin	Citric acid [mg/mL]	Acetic acid [mg/mL]	Tartaric acid [mg/mL]	Phosphoric acid [mg/mL]
1	0.13	0.01	0.88	–
2	1.81	0.97	–	–
3	0.13	0.01	0.37	0.32

Table 5: Results of the determination of organic acids in three alcohol-free gins

the acids that were tested, citric acid and malic acid, are very good with a regression value of R2 > 0.999 (Figures 6 and 7). According to the declaration, all ten tonic water samples contained citric acid (Figure 8), the content of which amounted to between 3.3 and 5.0 mg/mL (Table 4). Ascorbic acid could not be detected in any sample, despite being declared in one sample. Acetic acid was detected instead. Since ascorbic acid is used as an antioxidant, it can be assumed that the ascorbic acid has degraded through oxidation.

In the gin samples, the only significant results were found for the non-alcoholic gin varieties. The acids contained here are citric, acetic, tartaric and phosphoric acid (Figure 9 and Table 5).

Suitable for identification and quantification

The analyses have revealed which specific sugars and acids are present. The only surprise was one of the samples of tonic water: It was supposed to contain ascorbic acid, but this could not be detected. The methods described here – such as HILIC (hydrophilic interaction chromatography) and "post-column pH buffering with electrical conductivity detection" – are obviously suitable for identifying and quantifying sugars and organic acids in beverages.

→ **Nexera IC Ion Chromatograph**

References/further information

[1] https://www.shimadzu-webapp.eu/de/magazine/ausgabe-2025-01_de/

[2] https://www.mordorintelligence.com/de/industry-reports/tonic-water-market

More information and references:

Scan or click

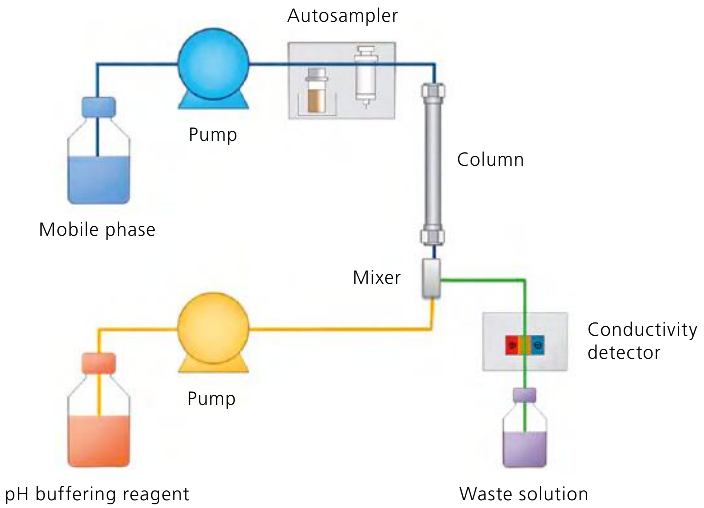


Figure 5: Flow diagram Nexera analysis system for organic acids

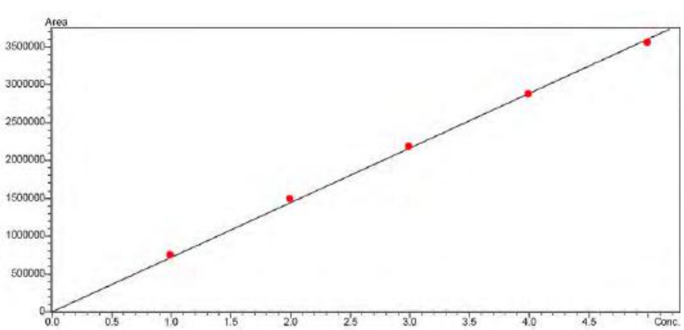


Figure 6: Calibration for citric acid 1.0–5.0 mg/mL

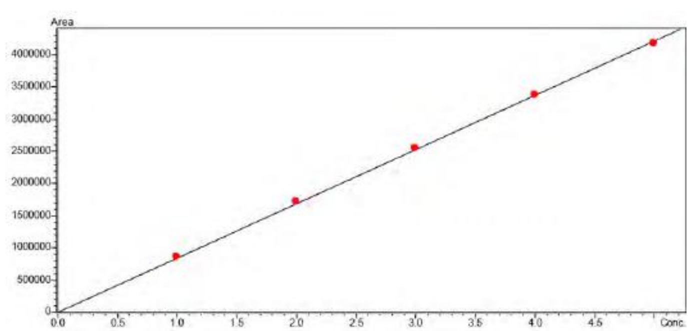


Figure 7: Calibration for malic acid 1.0–5.0 mg/mL

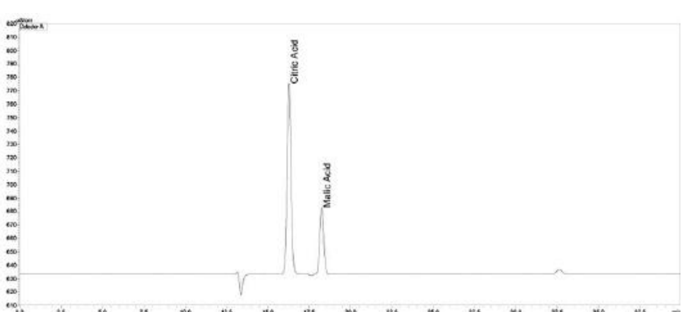


Figure 8: Chromatogram of a tonic water sample for the determination of organic acids

Figure 9: Overlay chromatogram of alcohol-free gins 1 (black), 2 (magenta) and 3 (blue) in comparison to the reference (brown)

From Orchard to Processing Plant

What Comes Next for the Food Industry

Author: **Peter Schellekens**, Project Manager Agriculture and Food, FME

Peter Schellekens is a project manager at FME, ecosystem orchestrator in NXTGEN Hightech Handsfree Agrifood and founder of the Dutch Fruit Tech Community (DFTC). He specializes in the convergence of advanced agricultural technologies and food processing, with a strong focus on robotics, data-driven production systems, and value chain integration. Through his work, he connects leading companies, technology developers, and research institutes, and plays an active role in shaping innovation programmes within the Dutch and European agri-food sector.

Why Food Processing Must Pay Attention to What Happens in Agriculture

Food processing and agriculture are often approached as separate domains. One focuses on efficiency, scale, food safety, and compliance, while the other deals with biological systems, weather conditions, labor, and land use. In practice, however, the two are closely connected.

Within programmes such as NXTGEN Hightech and initiatives like the Dutch Fruit Tech Community, it is increasingly clear that developments in agriculture are not only influencing, but actively reshaping what is possible and required further downstream in food processing.

In recent years, challenges at farm level have rapidly translated into consequences for processors. Labor shortages, stricter sustainability requirements, climate variability, traceability demands, and rising expectations around transparency and environmental performance all play a role. Against this backdrop, gaining a better understanding of upstream developments is no longer optional for the food industry, particularly in high-value segments such as horticulture and fruit production.

This article outlines how technological, organizational, and systemic changes in primary production are reshaping food processing, and why it is essential for processors to engage more actively with these developments.

Changing Conditions in Primary Production

Across Europe and other advanced agrifood regions, agriculture is undergoing structural change. Several long-term trends are converging.

- Increasing labor scarcity is making it more difficult and costly to secure seasonal and skilled workers, particularly in labor-intensive crops such as fruits and vegetables.
- Rising sustainability requirements are tightening expectations around pesticide use, water efficiency, soil health, and biodiversity.
- Climate variability introduces growing uncertainty in yields and product quality due to extreme weather, shifting seasons, and rising disease pressure. • Digital compliance and traceability are turning data collection into a requirement rather than an option, covering everything from inputs to product origin.

These developments are structural in nature and will continue to influence how raw materials are produced, harvested, and delivered to processors. Within the Dutch Fruit Tech Community, this is reflected in the increasing urgency among both growers and technology providers to move towards more data-driven and scalable production systems.

Technology as a Response: From Manual to Data-Driven Agriculture

In response to these pressures, agriculture is rapidly adopting new technologies. In fruit

production in particular, four developments stand out:

- Robotics and automation for harvesting, pruning, and crop monitoring
- Sensor-based systems for yield estimation, ripeness detection, and disease monitoring
- AI-driven decision support combining weather data, crop models, and operational planning
- Precision technologies that reduce input use while maintaining or improving quality

Within the NXTGEN Hightech programme, specifically the 'Tree to Plate' activity, we focus on how value can be created across the apple and pear value chain by implementing high-tech solutions that increase homogeneity in the orchard and improve overall output quality. In practice, one of the key challenges we encounter in this context is not the availability of technology itself, but aligning requirements and expectations across the chain – from growers to processors – so that innovations deliver measurable value beyond the orchard.

At recent industry events such as Fruit Logistica 2026, it has become increasingly clear that these technologies are moving beyond experimentation and into early-stage deployment. For the food industry, the relevance lies not in individual technologies, but in the broader shift they create: farms are becoming data-driven production environments. This allows producers to achieve higher and more consistent quality while reducing the use of inputs such as labor, water, and crop protection.

For processors, this shift is highly relevant, as increased consistency and predictability at farm level directly translate into improved planning, lower operational volatility, and ultimately reduced costs in processing operations.

Implications for Food Processing Operations

As upstream production becomes more technology-driven, food processors are likely to face both new opportunities and rising expectations. Four implications stand out:

More predictable raw material flows. Improved sensing and forecasting can reduce uncertainty in volumes, timing, and quality – provided that processors are equipped to work with this data.

Higher transparency requirements. Digitalization at farm level enables detailed traceability, which processors will increasingly need to integrate and communicate to customers and regulators.

A shift in quality management. Quality control is gradually moving upstream, influencing variety selection, cultivation practices, and harvest timing, rather than relying solely on downstream sorting and correction.

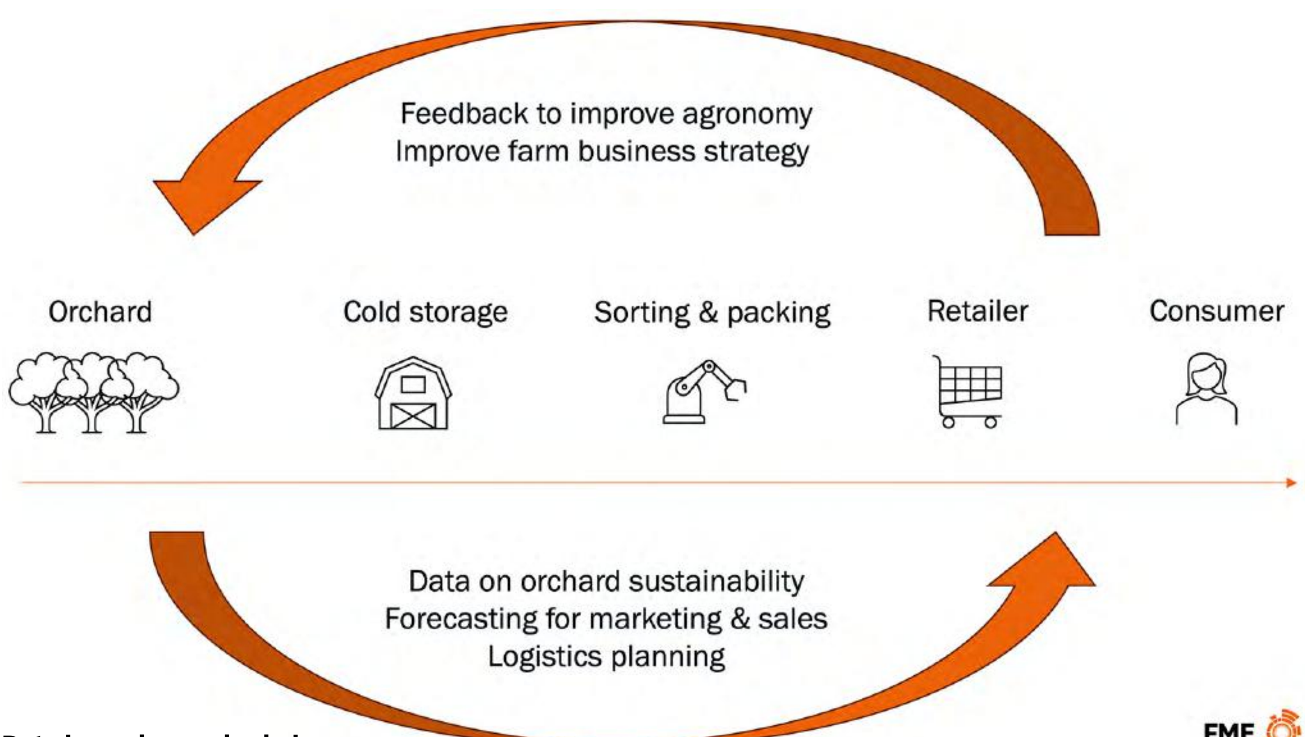
Closer chain integration. The traditional transactional relationship between growers and processors is evolving toward more collaborative models, where data, planning, and technology choices are aligned across the value chain.

This also raises a fundamental question for the industry: who will ultimately finance this transition? If upstream digitalization leads to more accurate forecasts, greater consistency in raw materials, and more stable and cost-efficient processing operations, a significant part of the value is clearly captured downstream. It is therefore increasingly questionable whether a traditional buyer–supplier model is still sufficient, or whether processors should take a more active role as partners, including co-investing in the technologies that enable these improvements at farm level.

Demonstration Over Theory: Accelerating Technology Adoption

A key lesson from agricultural innovation is that technology adoption does not primarily occur through reports or pilot studies, but through practical demonstration in real-world conditions.

Across Europe, growers, technology developers, and value chain partners are increasingly working together in demonstration environments – on real farms, with real crops, and under real operational constraints. This approach accelerates learning, reveals limitations early, and builds trust between stakeholders.



Data in apple supply chain

For the food industry, this model is directly relevant. Processors that engage early – by participating in field demonstrations, sharing performance requirements, or co-developing solutions – can position themselves advantageously. In doing so, they help shape the technologies that will ultimately affect raw material characteristics, availability, and cost.

The Role of Ecosystems and Collaboration

The complexity of current challenges increasingly exceeds the capacity of individual companies, whether farms, processors, or technology suppliers. As a result, innovation ecosystems are emerging that bring together:

- Farmers and grower organizations
- Machinery and technology suppliers
- Food processors and brand owners
- Research institutions and applied scientists
- Public authorities and funding bodies

These ecosystems focus not only on technological development, but also on system-level challenges such as interoperability, standards, data governance, and viable business models.

Through initiatives such as the Dutch Fruit Tech Community, these ecosystems are actively facilitated, bringing together stakeholders across the fruit sector to align innovation agendas, share knowledge, and accelerate implementation in practice.

For food processors, participation in such ecosystems is no longer limited to long-term innovation agendas. It is becoming directly relevant to day-to-day operations, as decisions made within these ecosystems will shape future raw material streams.

Bridging the Gap: From Agricultural Innovation to Industrial Application

A recurring challenge lies in translating agricultural innovation into solutions that fit industrial processing environments. Technologies that perform well in the field do not always meet downstream requirements in terms of throughput, hygiene standards, certification, or cost efficiency.

This gap can be reduced when processors are actively involved at an early stage and clearly articulate their requirements. Key questions include:

- What level of consistency is required in raw materials for optimal processing results?
- Which data formats and system interfaces are usable in existing operations?
- How should sustainability metrics be translated into procurement criteria?

Early alignment helps to reduce friction later in the chain and increases the likelihood that innovations create value beyond the farm gate.

Looking Ahead: Strategic Questions for the Food Industry

As agriculture continues to evolve, the food industry is confronted with a number of strategic questions:

- How closely should we integrate primary production data into our operations?
- Are planning and logistics systems prepared for more granular and dynamic inputs?
- Do we view agricultural innovation as a peripheral development, or as a strategic asset?
- Where does collaboration across the chain deliver more value than traditional sourcing models?

While there are no simple answers, ignoring these questions is becoming increasingly risky.

Conclusion

Food processing and food safety have long been at the core of industrial innovation. Today, a new frontier is emerging upstream, as agriculture is transforming into a data-rich, technology-driven production environment with direct consequences for processors.

In initiatives such as NXTGEN Hightech, it becomes clear that improving performance at farm level increasingly requires coordinated action across the entire value chain, including active involvement from the food processing industry.

Companies that engage early – technically, organizationally, and strategically – will be better positioned to manage risks, improve efficiency, and meet evolving market and regulatory demands. As this transition unfolds, questions around value distribution and roles within the value chain will become increasingly relevant, particularly as the benefits of improved predictability and consistency extend beyond the farm level.

Understanding what comes next in agriculture is therefore not a distraction from food processing; it is a prerequisite for maintaining long-term competitiveness.

Small-portion powder products as value drivers

Why packaging suitability is already decided in the mixing process

Author: **Prof. Rainer Barnekow**, Technische Hochschule Ostwestfalen-Lippe, Lemgo, rainer.barnekow@th-owl.de

Small packaging such as sticks, sachets, or capsules offers the food industry significant economic advantages, but places high demands on both the product and the process. Powdered products, in particular, often exhibit shortcomings in their suitability for packaging. This article explains why these challenges frequently arise during the mixing process and why traditional mixing technologies are increasingly reaching their limits.

Introduction: Economic Pressure Meets Physical Reality

Small-portion packaging units have become the preferred format in many segments of the food industry. They are not only convenient for consumers, but also allow manufacturers to achieve significantly higher added value per kilogram of product. However, this economic advantage can only be realized if the packaging is produced consistently and reproducibly at high production rates.

This is precisely where a fundamental tension arises: While packaging machines are designed for maximum speed and precision, many powder products exhibit properties that contradict these requirements. High dust content, segregation effects, fluctuating bulk densities, and inadequate flow properties lead to unstable processes, increased rejects, and ultimately, economic losses.

Powder Behavior as a Limiting Factor

The causes of inadequate packaging rarely lie solely in the filling technology. Rather, it is a complex interplay of materials science and process engineering factors. Powders are not ideal solids, but behave differently depending on their composition, degree of dispersion, and bulk material history.

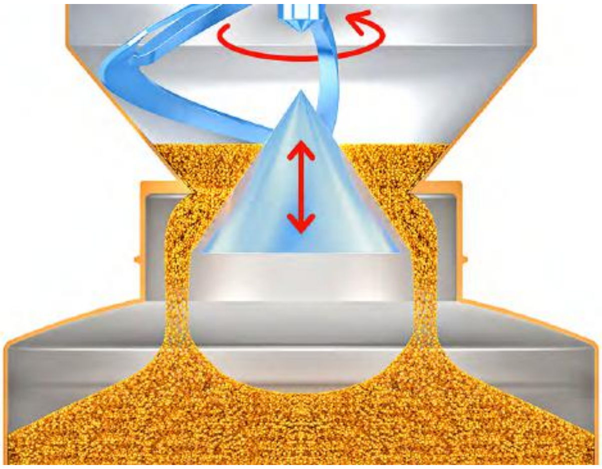
Fine particle fractions increase cohesion and promote dust formation, while at the same time the tendency for segregation increases as soon as different particle sizes or densities are present. In addition, many food powders are hygroscopic or contain fats, which further impairs the flow properties. Consequently, dosing becomes inaccurate or unstable at high cycle rates.

The Underestimated Key Process: Mixing

A crucial, yet often underestimated, process step is mixing. In practice, the focus

With the amixon® KoneSlid® mixer, powders can be mixed in seconds and discharged completely.

ll materials to be mixed are moved at the same time. Each particle moves relative to its neighboring particles. Their distribution is the result of a dead-space-free random motion.



Cone-valve discharge systems can discharge products either quickly or slowly. They can even function as a dosing system.

is almost exclusively on the mixing quality in terms of a homogeneous distribution of the components. Parameters such as thermal stress, mechanical strain, or dust generation, on the other hand, are often only considered peripherally.

However, it is precisely here that the course is set for the subsequent suitability for packaging. Intensive mixing processes can lead to particle abrasion, which significantly increases the proportion of fines. At the same time, high shear forces and long mixing times generate undesirable heating and electrostatic charging of the product. Heating is particularly critical with fatty or temperature-sensitive components, as it can lead to partially sticky surfaces. The result is powders with significantly altered flow properties and an increased tendency to form bridges.

Many established mixing systems that have been reliably used for decades are increasingly reaching their limits under these demands. Classic intensive mixers or high-speed systems are often not designed to guarantee the balance between sufficient mixing and minimal particle degradation. These limitations are particularly evident with modern formulations containing functional additives, proteins, or sensitive micronutrients.

From Mixing Quality to Process Quality

The analysis of the mixing process must therefore be broadened. In addition to pure homogeneity, further quality parameters come into focus: particle integrity, temperature profile, dust generation, and resulting bulk material properties. The crucial factor is not only whether a product is well mixed, but also whether it can subsequently be conveyed, dosed, and packaged reliably.

A shift in thinking towards a holistic process approach is necessary. The goal is a powder that not only meets nutritional and sensory requirements but also exhibits defined

Efficient mixing without damaging fragile components

physical properties. These include a narrow bulk density distribution, reproducible flowability, and low dust tendency.

Approaches to Improved Packaging

Modern developments in mixing technology address precisely this point. Today, there is a demand for mixing equipment that offers a high degree of flexibility with regard to fill level, batch size, and product characteristics. This makes it possible to process a wide variety of formulations and bulk materials reliably and reproducibly, without having to compromise on homogeneity or economic efficiency. The selection of the appropriate mixing system is therefore becoming an increasingly decisive factor for the entire process chain.

Moderne Entwicklungen im Bereich der Mischtechnik setzen genau an diesem Punkt an. Gefragt sind heute Mischapparate, die eine hohe Flexibilität hinsichtlich Füllgrad, Chargengröße und Produkteigenschaften bieten. Dadurch lassen sich unterschiedlichste Rezepturen und Schüttgüter prozesssicher verarbeiten, ohne Kompromisse bei Homogenität oder Wirtschaftlichkeit eingehen zu müssen. Die Wahl des geeigneten Mischsystems wird damit zunehmend zu einem entscheidenden Faktor für die gesamte Prozesskette.

Lindor Mixer L 3000

For particularly sensitive powders and formulations with high demands on maintaining particle structure, modern vertical single-shaft mixers with sinconcave mixing tools and virtually segregation-free discharge are used. The slow, three-dimensional redistribution of the bulk material achieves high homogeneity with minimal mechanical stress. Homogenization is achieved primarily through the controlled guidance of the product flows and less through intensive shear forces. This significantly reduces particle abrasion, dust generation, and structural changes. Especially with fragile products such as instant beverages, dietary supplements, or agglomerated powders, the flow and bulk material properties crucial for subsequent dosing and packaging can be preserved. The virtually segregation-free discharge ensures that the product quality achieved during the mixing process is maintained in subsequent process steps, enabling stable, high-performance filling processes.

In parallel, targeted particle design is increasingly coming into focus. Upstream agglomeration or granulation steps allow for the creation of defined particle structures that improve both flow properties and dosing. Crucial to this is the close integration of formulation development, mixing technology, and the packaging process.

Conclusion

The successful marketing of small-portion powder products requires more than just high-performance packaging systems. The foundation for stable, high-performance processes is laid much earlier in the manufacturing process – particularly during mixing. Those who focus solely on mixing quality in the traditional sense risk serious disadvantages in downstream processing.

In the future, competitiveness will increasingly depend on the extent to which powders can be specifically designed to meet the requirements of modern, high-speed packaging. The mixing process plays a key role here – not only as a homogenization step, but as a crucial factor for overall process and product quality.

The Protein turnaround

Why alternative proteins are not a matter of lifestyle – but of necessity.

Author: **Godo Röben**, Management Consultant, Keynote Speaker and member of several supervisory and advisory boards in the food industry godoroeben@gmail.com

It was 2010 when we at Rügenwalder Mühle started to think the unthinkable: a traditional meat and sausage brand seeking its future in plant-based alternatives. The reactions at the time ranged from amusement to open resistance. Today, 15 years later, Rügenwalder Mühle generates over 50 percent of its revenue with vegetarian and vegan products – making it the largest plant-based brand in Europe. What sounds like a company story is actually a blueprint. For a transformation which the entire food industry faces.

Three Unsolvable Problems – One Necessary Way Out

Let me begin: All companies that currently carry animal products in their range face three structural problems that they cannot simply talk away.

The first is factory farming. Worldwide, 150 billion animals are killed and eaten every year. The conditions in which these animals are kept are constantly in the public consciousness thanks to social media – there is no going back to a time when consumers could ignore this. Furthermore, the extensive interbreeding of farm animals and wild animals is a breeding ground for zoonoses.

The high use of antibiotics increases the risk of resistance. These are not fringe issues for activists – these are realities of public health.

The second problem is climate change. Meat and fish consumption are currently the main drivers of greenhouse gas emissions—even more so than the entire transportation sector. By 2050, if we continue as we are, we would have to raise twice as many animals as we do today. This is neither ecologically nor resource-wise conceivable. Vegetarian and plant-based foods are not a matter of ideology in this logic. They are—like renewable energies or electromobility —a societal obligation.

The third problem is global population growth. Stephen Emmott, in his book "10 Billion," impressively described what lies ahead: By 2050, 9 to 10 billion people will live on Earth.

The demand for food will double. It is simply impossible to feed so many people the way we do today—with the same proportion of animal protein. The food industry will have to find answers. The question is not if – but when, and who.

No sacrifice – better products.

At this point, I would like to dispel a persistent misconception: The answer to these challenges is not sacrifice. Sacrifice has never worked as a societal transformation program.

In the energy transition, we didn't shout "Lights out!" – we developed wind, solar, and hydropower to complement coal and nuclear power. In the mobility transition, we didn't demand "Buses and trains!" – we developed electric and hydrogen drives that gradually replace diesel and gasoline. The agricultural transition works in the same way: Not "Veggie Day!", but plant-based proteins that complement animal proteins – and largely replace them in the long term.

This is crucial because it touches upon the core of the business model: Over 80 percent of vegetarians and flexitarians enjoy the taste of meat and sausage. They don't abstain because they dislike meat – they abstain because they can no longer ignore factory farming, climate change, and health concerns. So, whoever offers them a product that tastes just as good, creates the same eating experience – and doesn't have these three problems – wins. Not the vegan. The flexitarian. And that's 46 million people in Germany.

What Rügenwalder Mühle teaches: Disruption from within.

In 2013, Rügenwalder Mühle was a strong, established brand with a clear positioning and loyal customers. What many forget: This was precisely the greatest danger. Strong brands tend to become immune to change. The temptation to protect the status quo is strongest where things are still going well.

The transformation process at Rügenwalder was anything but smooth. The resistance was as strong internally as it was externally. Sales didn't want to waste resources on a niche product. Production doubted whether quality could be maintained. Management feared cannibalization of the core brand. And retailers? Initially showed little interest. Today, the result is clear: over 50 percent of sales are vegetarian/vegan. A new category in the grocery retail sector, represented in all distribution channels.

The lesson here is not that all companies should simply restructure their product range. The lesson is: disruption that is not driven internally comes from the outside. And those who wait until the external pressure is great enough have usually missed the best years for transformation.

The Three Major Turning Points and the Parallels to the Food Industry

Our society is undergoing three profound transformations: the energy transition, the mobility transition, and the agricultural transition. All three follow the same pattern – and all three will force the companies that miss them out of the market.

Stephan Kolle, founder of the creative agency Kolle Rebbe, put it aptly: "The era in which we live is undergoing extreme change: 30 percent of the companies that are large today will no longer exist in ten years." This is not a threat – it is a statistically verifiable observation from economic history.

Kodak, Nokia, Blockbuster – they all observed disruption from a distance instead of actively shaping it.

In the food industry, we are currently witnessing how the dairy industry is being reinvented. How the sausage industry is being reinvented.

The companies that set the right course now – not as a PR stunt, but as a core strategic decision – will be the winners of this transformation.

The consumer has long since made up their mind

A frequently heard objection in management meetings is: "Our customers don't want that at all." I hear it regularly – and I regularly refute it with the same data.

The shift in food culture is undeniable. Stars and opinion leaders play a role that shouldn't be underestimated – not because celebrities set trends, but because they signal social acceptance. Brad Pitt, Beyoncé, Lewis Hamilton, Mike Tyson, Kate Winslet, Billie Eilish – the list of prominent people who have opted for a plant-based lifestyle is long. In Germany, this has also long entered the mainstream.

This doesn't change the core product – but it does change the social context. Plant-based nutrition is no longer a symbol of deprivation or belonging to a fringe group. It is an expression of a modern, informed lifestyle. And that is precisely what creates the cultural conditions for mass-market products.

The Market: Figures Strategists Should Take Seriously

Let me present a few figures to clarify the picture: In Germany today, there are 8 million vegetarians, 1.3 million vegans, and 46 million flexitarians. 54 percent of the population wants to eat more healthily and sustainably. 37 percent want to eat less meat. One-fifth of Germans eat plant-based meat alternatives at least once a week. 25 percent want to further increase their consumption in the coming years.

The global meat and sausage market is worth approximately 1.2 trillion US dollars. The vegetarian and vegan market was worth around $6 billion in 2024 – with a forecast of $120 billion by 2040. This corresponds to growth to 10 percent of the meat market. Studies by AT Kearney, Barclays, and JP Morgan arrive at similar assessments. This is no longer a niche market. This is one of the biggest growth opportunities in the global food industry.

The interest from capital and corporations is correspondingly high. Google has declared plant-based meat one of its six global "game-changing trends"—alongside autonomous driving, 3D printing, and virtual reality. Eric Schmidt, then Google CEO, saw it as the "most revolutionary trend" of the next decade.

Alternative Proteins: The Three Paths of the Future

When I talk about alternative proteins, I mean three fundamentally different technological approaches that will complement each other: Plant-based products are currently the most advanced and commercially mature path. They utilize raw materials such as peas, soy, wheat, or rapeseed and create products that mimic the texture, taste, and cooking properties of meat. The quality has improved dramatically in recent years—and by 2027/2028, it will reach a level where most consumers will no longer be able to discern a significant difference in a blind taste test.

Fermentation uses microorganisms to produce proteins that are deceptively similar to animal products—especially in the area of cheese and dairy products. Companies like Formo (formerly Better Dairy) from Berlin are working on producing real mozzarella and parmesan from fermentation-based cheese without needing a single cow. Cell-cultured meat—meat grown from animal stem cells without slaughtering the animal—is still in an early commercial phase. Companies like Mosa Meat (Maastricht), Upside Foods (San Francisco), and SuperMeat (Israel) have proven the concept technologically. The regulatory and economies of scale issues are not yet fully resolved, but the direction is clear.

Of particular relevance for community catering and commercial kitchens

Anyone working in community catering—whether in company canteens, hospitals, care facilities, schools or chain restaurants—faces a particular challenge and opportunity at the same time.

The framework conditions are clear: cost efficiency, scalability and acceptance among a broad, often unchosen audience. This is precisely where the strategic leverage for alternative proteins lies.

Anyone who offers a plant-based dish on the menu every Monday in a company cafeteria reaches millions of meals in a year – without a single consumer having consciously made a dietary choice. This is the quiet power of institutional catering: It changes habits without persuasion. And it gives companies in the out-of-home catering sector the unique opportunity to be part of a societal transformation – with a clear business rationale.

The forecast for 2027/2028: All important plant-based product categories will be on par with their animal-based counterparts in terms of taste.

For commercial kitchens, this means: Anyone who hasn't built up a solid product range and expertise by then will come under pressure – from customers, from buyers, from tender requirements.

What companies need to do now

The central question isn't: "Should we be dealing with alternative proteins?" It's: "How quickly do we need to be dealing with them – and how deeply?"

My answer, based on 15 years of active work in this segment: Companies that start now still have the opportunity to build market share and brand positions before the cutthroat competition really kicks in.

In three to five years, the shelves will be full – with products that taste good, are inexpensive, and are available everywhere. Anyone still trying to justify their entry then will have to fight against established brands. Specifically, I recommend three approaches:

First: 100 percent copies instead of compromises. The most successful plant-based products are 1:1 alternatives. Salami, Nutella, Bress, Barista… They are deceptively realistic copies. A vegetarian ham that tastes like ham. A vegan sausage that tastes like a sausage. Anyone who accepts compromises in taste loses the flexitarian – and thus the mass market. And if you don't make a 100% copy, then create something entirely original.

Second: Ubiquity as a goal. Alternative proteins must be available everywhere animal products are currently offered – grocery stores, discount stores, gas stations, canteens, commercial kitchens, chain restaurants, trains, airlines. Niche distribution is the enemy of the mass market.

Third: Clean label as a differentiating factor. Consumers don't want a list of chemicals on the back. Technological developments increasingly allow products to be manufactured with fewer additives. Those who establish this as a positioning early on have a sustainable advantage.

Conclusion

Those who want to survive must change. The message of my work – in consulting, on stage, in supervisory and advisory boards – is always the same: Change is not an option. It is the only strategically viable response to what is structurally coming our way.

The good news: We are not facing collapse. We are facing one of the greatest waves of innovation the food industry has ever seen.

Companies that harness the energy of this wave—that invest in product development, partnerships, and strategic positioning—will emerge stronger from this decade.

Rügenwalder Mühle proved it.
It's possible. And it's worth it.

About the Author

Godo Röben is a management consultant, keynote speaker, and member of several supervisory and advisory boards in the food industry.

Under the brand Food | Rethinking, he supports companies in their strategic transformation towards alternative proteins.

From 2010 to 2020, he was responsible for building the plant-based division of Rügenwalder Mühle into Europe's largest vegetarian brand. Today, he holds positions at companies including Lidl Germany, REWE Group, Privatmolkerei Bauer, Planted, Billie Green, Project Eaden, and Follow Food.

» **Official analysis procedure L00.00-18** for the determination of total fiber content in acc. with § 64 LFGB)

» **AOAC 985.29** total crude fiber analysis (the so-called Prosky method)

» **AOAC 991.43** total crude fiber analysis (applicable for the determination of total crude fiber content in grain, beans, vegetables and fruits)

Determination of the fiber content

Your benefits:

» Perfect mechanical interplay of individual components: Precise analysis is guaranteed with the behr filtration equipment

» Practical addition and removal of max. 6 behrotest® crucibles

» Space-saving equipment: Perfect sizes for any conventional lab table

» Simple extraction of sample in the designated collection bottle

» Low filtration times: behrotest® Diaphragm vacuum pump, with high chemical resistance, to facilitate work during filtration and rinsing

Quality made in Germany

behr Labor-Technik GmbH • Spangerstraße 8 • 40599 Düsseldorf/ Germany
Phone: +49 211 74847-17 • email: info@behr-labor.com
Internet: www.behr-labor.com

behr Labor-Technik