Solutions for Protein Determination
Whatever you need: Kjeldahl, Dumas or NIR

BUCHI is the only provider of the three most widely used technologies for nitrogen and protein determination. Our Kjeldahl, Dumas and NIR solutions meet any distinctive need whether you are involved into incoming or outgoing goods inspection, at-line production control or quality control for declaration purposes.
Core messages to our customers
BUCHI creates added value with “Quality in your hands”

“Quality in your hands” is the guiding principle that shapes our philosophy and our actions. It challenges us to provide outstanding services that are precisely tailored to your needs. This means that we must stay in close contact with our customers. That is why we keep in touch and continue to work very hard to understand you and your business even better.

We help you by providing high-quality products, systems, solutions, applications and services that offer you added value. This allows you to focus entirely on your processes and your work.

Easy
You handle complex processes, do challenging work and want to focus on what is essential. We support you by providing carefully designed solutions as well as instruments and systems that are easy to operate.

Competent
You need products, systems, solutions, applications and services that are precisely tailored to your needs. We have the technological expertise and decades of experience needed to provide competent support and work with you to continually improve our market services.

Reliable
You want to be able to rely completely on your partner for products, systems, solutions, applications and services. We guarantee the quality and functionality of our equipment and will continue to help you quickly and efficiently whenever something does not operate to your satisfaction.
Global
You value personalized service and short communication channels. As an international family-owned business with our own subsidiaries and qualified distributors, we have a presence wherever our customers are located. Our local staff and the large number of satisfied customers around the world give you the assurance that you are working with the right partner.

Cost-effective
You want to achieve the best possible results using efficient solutions. We help you to handle your jobs and processes economically. We strive to create a high level of economic benefit and maximum added value for you.

Safe
You are working in an environment in which safety is a high priority. By collaborating closely with you, we do everything in our power to make our products, systems, solutions, applications and services as safe as possible for people and the environment.

Sustainable
You prefer a partner who acts responsibly when it comes to current environmental challenges. We support environmentally friendly processes and manufacture products that have a long service life. We utilize advanced technologies in order to conserve energy and water and leave the smallest environmental footprint possible.
**We offer solutions for protein determination**

Kjeldahl, Dumas, NIR: a complementary set of technologies

Processed food, beverage, feed or forage pass different steps in their production cycle. They require different technologies for the determination of nitrogen or protein. Whether you need fast qualification of raw material or precise protein declaration of processed goods, our Kjeldahl, Dumas and NIR solutions cover it all.

<table>
<thead>
<tr>
<th>R&amp;D</th>
<th>Food / Beverage</th>
<th>Feed / Forage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product development</td>
<td>«Protein Determination Kjeldahl» (p. 6); «Protein Determination Dumas» (p. 8)</td>
<td></td>
</tr>
<tr>
<td>Warehouse</td>
<td>Raw material qualification, goods inspection</td>
<td>Raw material qualification, goods inspection</td>
</tr>
<tr>
<td>Production</td>
<td>Intermediate production steps control</td>
<td>Formulation optimization</td>
</tr>
<tr>
<td>Finished product</td>
<td>Nutritional label verification</td>
<td>Label compliance</td>
</tr>
</tbody>
</table>
There are many factors which influence the selection of the most suitable method to determine nitrogen or protein. Whereas Kjeldahl is a proven method for all kind of sample matrices, Dumas excels in unattended processing at high throughput, and NIR is matchless in terms of immediate and comprehensive multi-component analysis.

Find a comprehensive list of differentiating criteria on page 12 or on our website: www.buchi.com/protein
You cope with ever changing matrices, with varying sample loads and other analytes than just nitrogen or protein. Our solution «Protein Determination Kjeldahl» offers you a robust method for varying sample matrices and numbers. It can also be used for various analytes other than protein and is compliant with many regulations.
Your most important benefits

Established and proven

- Kjeldahl is the most established reference method for protein determination in food, beverage, feed and forage. It commonly serves as reference for NIR calibrations.
- It is compliant with all sorts of national and international regulations such as AOAC, ISO, DIN, LFGB and many more.

Versatile

- Changing matrices or highly heterogeneous samples are easily handled by Kjeldahl.
- It copes with just a few samples per day or with a high throughput of up to 120 samples in a shift thanks to a flexible autosampler concept.
- Acid digestion and steam distillation can be applied for the determination of various analytes such as N-containing compounds, COD, heavy metals, hydroxyproline, SO₂, formaldehyde, CN, diacetyl, alcohol, TVBN, volatile acids, phenols etc.

For every budget

- Our broad portfolio offers entry-level Kjeldahl products up to highly sophisticated fully automated systems.

Your solution «Protein Determination Kjeldahl»

- Distillation, titration: KjelMaster K-375
- Autosampler: KjelSampler K-376 or K-377
- Digestion: KjelDigester K-449
- Neutralization: Scrubber K-415 (TripleScrubECO)
- Cooling: Recirculating Chiller F-114
- Homogenization: Mixer B-400
- Data Management: KjelLink PC Software
- Comprehensive list of reference applications
- Customized application support
- Authorized IQ/OQ documentation
- Useful tools for application development
- Practical workshops, trainings and seminars
- Preventive maintenance including IQ/OQ
- Minimize downtime thanks to our service hotline

“BUCHI’s flexible Kjeldahl solution makes it possible to efficiently determine protein, TVBN and pespin. The ideal procedure for quality control.”

Mrs. Suporn Pintong, Quality Control Manager, Grobest Corporation Co. Ltd., Thailand
Solution «Protein Determination Dumas»
Dumas: unattended operation and “random access”

You cope with high sample loads for QC and declaration purposes with little changes in the sample matrices. Our solution «Protein Determination Dumas» offers sample throughput of up to 300 samples per day, overnight operation without supervision and an easy-to-use operation concept.
Your most important benefits

Unattended and fast

- Rapid analysis times of approximately 4 minutes per sample
- Up to 300 samples per day with integrated autosampler (60 samples, ≤ 1 g or 120 samples, ≤ 300 mg)
- Unattended operation thanks to autosampler without any need of sample stacking
- Quick evaluation of suspect samples for at-line production control or quality control purposes

Easy to use

- Highest process flexibility as intelligent software allows for changing sequences at any time (“random access”)
- Highest reliability with computer-assisted leak check (gas flow, pressures)

Safe and cost efficient

- No direct contact with hazardous chemicals
- No risk of burns as the product is well insulated and protected
- Maximize up times with innovative, long-life Regainer-Reducer technology
- Save costs for consumables using lower priced carbon dioxide as carrier gas instead of helium

Your solution «Protein Determination Dumas»

- Combustion: DuMaster D-480
- Homogenization: Mixer B-400
- Weighing: analytical balance, e.g. Mettler-Toledo MS105-DU
- Sample preparation: capsule sealing press for liquids, manual pressing tool for solids, solid sample former for the use of paper instead of tin
- Data management: PC Software
- Customized application support
- Authorized IQ/OQ documentation and preventive maintenance
- Practical workshops, training and seminars
- Minimize downtime thanks to our local support

"On-site, rapid and accurate determination of protein has proved invaluable and compliments our NIR detection systems. It has been especially useful for our wet fresh meat samples and QC throughout our meat kitchens and Freshtrusion production facility. I would recommend the equipment."

James Lawson, Joint MD GA Pet Food Partners, United Kingdom
You cope with ever increasing sample inspection to sustain high quality control in food and beverage production as well as feed and forage ingredients, pre-mix and final products. Our solution «Protein Determination NIR» enables you to instantly and easily analyze a broad range of sample properties, from nutritional components to organoleptic quality.
Your most important benefits

Immediate

- Analytical results are generated within less than a minute.
- Incoming raw materials and outgoing goods are instantly screened.
- Adulteration (concentration > 1%) is promptly revealed for closer inspection and analysis.

Comprehensive

- Simultaneous and reproducible analysis of several parameters like protein, fat, moisture, nutraceuticals and many more is achieved thanks to the precise and robust polarization FT-NIR technology.
- Our set of IP protected NIR products can be used for at-line analysis of various matrices such as solids, liquids, powders, granulates, tablets, capsules, gels, paste etc.

Easy to use

- Our quick-start calibrations reduce inspection procedures to a push of a button.
- Networking tools provide fast comparison of the results among different facilities as well as automated data transfer to ERP and formulation systems.
- Convenient remote support is provided by our global network of experts.

Your solution «Protein Determination NIR»

- Analysis: NIRMaster™ Pro IP65
- Calibrations: Quick-start calibrations
- Software suite: NIRCal® calibration Software, NIRWare® for advanced application development, NIRAnywhere for spectrometers network management
- Homogenization: Mixer B-400
- Quick-start calibrations with dedicated application support
- LIMS and SAP compatibility
- Authorized IQ/OQ documentation and preventive maintenance
- Practical workshops, training and seminars
- Minimize downtime thanks to our remote support

“The NIR Solution convinced us primarily because of the consistency of the results throughout all global facilities, the quality of the hardware and the global service support network”

Christèle Dioré, Head of Analytical Testing Implementation, SPF – pet food division of DIANA, France
## Comparison by customer needs, application and characteristics

### Area of application

<table>
<thead>
<tr>
<th></th>
<th>«Kjeldahl» page 6</th>
<th>«Dumas» page 8</th>
<th>«NIR» page 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D</td>
<td>+++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Production</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Goods inspection</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Labeling</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
</tbody>
</table>

### Characteristics

<table>
<thead>
<tr>
<th></th>
<th>«Kjeldahl»</th>
<th>«Dumas»</th>
<th>«NIR»</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of applications</td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Variation in sample types</td>
<td>+++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Automated throughput</td>
<td>++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Speed</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Compliance ¹</td>
<td>+++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Detection of adulterants</td>
<td>++ (NPN)</td>
<td>++ (NPN)</td>
<td>+++</td>
</tr>
<tr>
<td>Unattended operation</td>
<td>++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>No contact with chemicals</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Ingress protection rating</td>
<td>+ (IP 20)</td>
<td>+ (IP 20)</td>
<td>+++ (IP 65)</td>
</tr>
<tr>
<td>Low initial costs</td>
<td>+ / ++ / +++ ²</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Low running costs</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Eco-friendly</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
</tbody>
</table>

### Technical Data

<table>
<thead>
<tr>
<th></th>
<th>«Kjeldahl»</th>
<th>«Dumas»</th>
<th>«NIR»</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput in 9 h</td>
<td>120 samples</td>
<td>~ 250 samples</td>
<td>~ 190 samples</td>
</tr>
<tr>
<td>Analysis time</td>
<td>200 min/20 samples</td>
<td>~ 4 min/sample</td>
<td>16 - 60 s/sample</td>
</tr>
<tr>
<td>Max. sample amount</td>
<td>&gt; 4 g/400 mL</td>
<td>1 g/1 mL</td>
<td>395 cm³/&gt; 0.3 mL</td>
</tr>
<tr>
<td>Limit of detection (LOD)</td>
<td>0.02 mg N</td>
<td>0.1 mg N</td>
<td>0.1 %</td>
</tr>
</tbody>
</table>

¹ With respect to application regulations such as AOAC, ISO, DIN etc.
² Initial costs of the Kjeldahl products are very much depending on the level of automation
³ Depending on sample composition, packaging material. No shift work assumed.

+ applicable            ++ more applicable       +++ most applicable
Analysis of pet food
GA Pet Food Partners, United Kingdom

Customer: world-leading manufacturing and nutrition expertise

Application: protein content of extruded dried pet food, raw materials including cereals, meat meals and fresh pasteurised meat is analyzed by Dumas combustion method.

Protein determination in soy protein isolate
Linyi Shansong Biological Products Co., Ltd., China

Customer: producer of natural, nutritional and functional foods

Application: soybeans are a rich natural vegetable protein source. The protein content is determined using the Solution «Kjeldahl».

Determination of protein, TVBN and pepsin
Grobest Corporation Co. Ltd., Thailand

Customer: leading aquatic feed producer

Application: protein, TVBN (Total Volatile Basic Nitrogen) and pepsin are determined for QC purposes in raw material and finished goods with the help of Kjeldahl Solutions.

NIRFlex® N-500 for sausage analysis
CPF Food Products Co. Ltd., Thailand

Customer: specialized in sausage production

Application: using the NIR Solution multiple components such as protein, fat, moisture and salt are analyzed for raw material inspection.

Explore more than 100 comprehensive case studies from all over the world on:
www.buchi.com/casestudies
Benefit from over 50 years of experience
Frequently asked questions

Get further detailed information about the differences in the three technologies regarding their throughput, the comparability among the methods, the detection of adulterations and the use for other analytes/parameters.

The analysis time is very different, why is the throughput comparable?

| General | A high throughput can be generated by a short sequence of multiple samples or by a high degree of parallelization. |
| Kjeldahl vs. Dumas | Dumas runs in a rapid sequential mode whereas Kjeldahl is slower, but digests 20 samples at once. This results in a comparable throughput over a working day. At the end of a working day DuMaster excels in unprecedented throughput as a further batch of 120 samples can be loaded and measured overnight. |
| NIR | The NIRMaster™ produces quantitative results in 30 – 60 seconds. Manual sample changing limits the throughput. |

| Kjeldahl parallel, automated (120 samples in 9 h) | 20 samples digested in 100 min | 20 samples distilled and titrated in 100 min | 20 samples digested in 100 min | 20 samples distilled and titrated in 100 min | etc. |
| Dumas sequential, automated (~120 samples in 9 h) | 1 sample in ~ 4 min | 1 sample in ~ 4 min | etc. |
| NIR sequential, manual (~190 samples in 9 h) | 1 sample in <60 s | manual change | 1 sample in <60 s | etc. |

Are results of the different methods directly comparable?

| General | None of the methods measures protein directly. While Kjeldahl determines the digestible nitrogen content, Dumas covers all N-sources and requires, like NIR, a calibration (secondary methods). It is therefore essential to declare the procedure / regulation which has been followed. |
| Kjeldahl vs. Dumas | Both methods measure the nitrogen content and use protein factors to calculate the protein content. Whereas Kjeldahl does this directly (titration), Dumas’ TCD signals need to be compared to a calibration curve. |
| NIR | NIR measures the electromagnetic radiation reflected, transmitted or absorbed by the samples. The generated spectra is compared to a set of spectra with known protein content. The better the reference values (typically generated by Kjeldahl), the better the NIR result. |
How can I detect manipulated protein content most efficiently?

**Background**
Cheap, nitrogen-rich chemicals like melamine are used to artificially adulterate the nitrogen and eventually the protein content of food/feedstuff.

**Kjeldahl, Dumas**
Both methods are, in principal, blind for the source of nitrogen which makes them vulnerable for adulteration. However, it is possible to separate non-protein nitrogen (NPN) from protein nitrogen prior to analysis if a sample appears suspect. A suspicious sample is best detected using NIR.

**NIR**
Properly calibrated, NIR is the ideal method to uncover adulterants. Further inspection and quantification of the suspect sample can then be done by any established method.

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**Kjeldahl and Dumas**

<table>
<thead>
<tr>
<th>Adulterated sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N-content of the sample</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**NIR**

Suspicious sample is detected

Quantification with reference methods or special calibrations

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What else, apart from nitrogen/protein, can be determined?

**Kjeldahl**
Both the digestion and distillation products of BUCHI can be used for much more than the determination of N-containing compounds such as: COD, heavy metals, hydroxyproline, SO$_2$, formaldehyde, CN, diacetyl, alcohol, TVBN, volatile acids, phenols etc.

**Dumas**
Classical Dumas products are limited to N-determination.

**NIR**
There is virtually no limitation in the determination of any kind of chemical or physical properties as long as it is abundant enough: protein, moisture, ADF, NDF, aminoacids, macrochemical composition, nutraceuticals, antioxidants and many more.
Complete your protein solutions portfolio
Complementary and related products

**FT-NIR**

The NIRFlex® N-500 offers FT-NIR spectroscopy in its most flexible way streamlining the analysis of complex matrices such as fluids, liquid and solid samples etc.

**Distillation**

The modular setup allows to adapt the KjelFlex K-360 at any time for the determination of protein and various steam-volatile compounds (e.g. SO₂, TVBN, CN, diacetyl, alcohol etc.).

**IR Digestion**

The SpeedDigester K-439 digests samples not only for protein but also for trace metal analysis and COD determination.

**Incineration**

The Wet Digester B-440 allows an ecological pre-incineration (up to 600 °C) for ash and sulfated ash determination.

**Hydrolysis**

Total fat declaration according to AOAC and Weibull-Stoldt is exhaustively achieved with the Hydrolysis Unit E-416 in conjunction with the E-816.

**Classical extraction**

The Extraction Unit E-816 provides very fast and convenient extraction of crude or total fat extraction in full compliance with AOAC regulations (HE and Soxhlet).
<table>
<thead>
<tr>
<th>Pressurized extraction</th>
<th>Rotary evaporation</th>
<th>Parallel evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The SpeedExtractor E-914 excels in pressurized solvent extraction (PSE) for the determination of residues, contaminants and additives.</td>
<td>The Rotavapor® R-215 is the product of choice for gentle evaporation of large volumes typically generated by Soxhlet extraction.</td>
<td>The Multivapor™ P-12 is a small and flexible tool for efficient simultaneous evaporation of multiple samples to dryness.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPE</th>
<th>Spray drying</th>
<th>Encapsulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Syncore® Analyst combines SPE clean-up with evaporation to pre-defined residual volumes. The ideal tool for contaminant and residue analysis.</td>
<td>The Mini Spray Dryer B-290 transforms liquids into definable micro size particles in order to encapsulate food ingredients such as flavors, proteins or vitamins.</td>
<td>The Encapsulator B-395 Pro allows to produce micro-capsules or -beads in a single step process to immobilize flavors, fragrances, vitamins or oils.</td>
</tr>
</tbody>
</table>
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From feasibility to preventive maintenance

You value an efficient and personalized service. Our network of professional application specialists and service technicians as well as a large number of satisfied customers around the world give you the assurance that you are working with the right partner.

Improve your applications
A team of highly qualified specialists continuously improve our reference application notes and calibrations. Ready-to-use detailed descriptions comprise of the entire process workflow. Customized solutions are developed in close cooperation whenever you face new requirements, changing circumstances or new parameters to be determined.

Find an overview of our applications at:
www.buchi.com/applications

Learn more about protein determination
Over more than 50 years of experience in protein determination resulted in a number of practical guides, scientific publications and useful apps. Improve your theoretical knowledge or find helpful tips and tricks for everyday laboratory practice.

Discover our literature at:
www.buchi.com/literature

Calibrations
BUCHI offers numerous quantitative applications with quick-start calibrations, for instance for meat and sausage products, feed and feed ingredients, various dairy products, cereal grains and many more. Thanks to the high sample variance obtained from different countries and companies, the BUCHI pre-calibrated applications are extremely robust.

Get an overview of our calibrations at:
www.buchi.com/calibrations
Profit from workshops, trainings and seminars
We regularly offer practical seminars and workshops, often in cooperation with other partners in the field of sample preparation and analysis. Customer contributions thereby underline how our solutions facilitate the daily routine. We also attend many local and international scientific and industrial congresses.

Find an overview of our activities:
www.buchi.com/events

Use your product most effectively
We help you to set your product properly into operation. We provide thorough Installation/Operation Qualification (IQ/OQ) services to ensure compliance with FDA, GLP/GMP standards or GAMP guidelines. Whether it is because of an initial installation, requalification or relocation, we provide professional compliance verification.

Find out more about our services:
www.buchi.com/service-support

Minimize downtimes
Avoid products downtimes with preventative maintenance and tailored service packages. We offer a product warranty of one year and guarantee ten years of spare parts availability.

Get in touch with us:
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