APPLICATION NOTE

elementar
EXCELLENCE IN ELEMENTS

Fast and automated N/protein analysis of plant-based protein food

CHALLENGE

Determination of protein content along the plant-based nutrition supply chain

Plant-based and climate-friendly nutrition are the top trends in nutrition in 2022 and beyond. The forecast for the global plant-based food market projects by 2030 the market will have more than doubled.
Within the plant-based nutrition market, research of new protein sources, development of high-tech ingredients and production of new tasty and nutritious plant-based products run at full speed. In each stage of the plant-based nutrition supply chain a fast and reliable protein determination is essential (Figure 1) as new farming and production processes emerge. These processes include: Breeding of new crops, optimization of organoleptic properties, novel methods for texturizing and structuring, and development of new product categories.

The determination of the total protein content according to international labeling laws is an important tool for quality control and protein declaration in the food industry. Protein content can directly correspond to product properties, texturing and functionality and can therefore be a decisive factor for product quality

INSTRUMENT

rapid MAX N exceed
(standard configuration)

SAMPLES:

- 0.2 g soy protein powder
- 0.2 g pea protein powder
- 0.2 g hemp protein powder
- 0.2 g rice protein powder
- 1.5 g oat drink
- 0.5 g cheese analogue from potato protein
- 0.5 g sausage analogue from pea & soy protein
- 0.5 g burger patty analogue from pea & rice protein

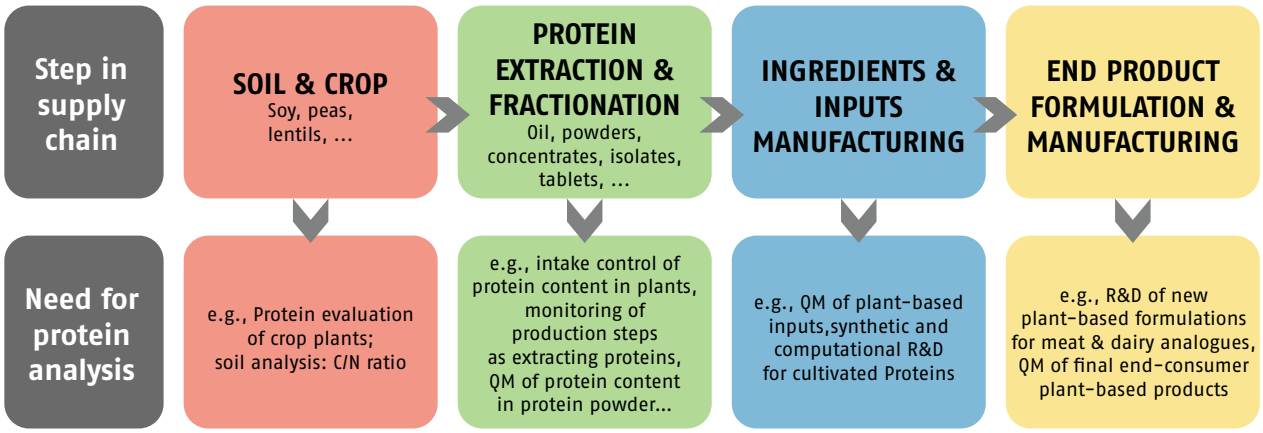

Figure 1. Protein analysis along the plant-based nutrition supply chain.

and price. In plant-based food analysis, highly precise, matrix-independent analyses of samples from various sources with different protein concentrations, solid and liquid, are required. Furthermore, the food tech industry is creating product innovations with highly automated and digital processes and is looking out for solutions that fit into their digital environment. Quick maintenance and a comprehensive monitoring from sample feeding to the measurement result play an important role.

SOLUTION

Simple, flexible, and eco-friendly N/protein analysis with the rapid MAX N exceed

The rapid MAX N exceed nitrogen and protein analyzer operates according to the safe, simple, and eco-friendly Dumas combustion method and offers fast and cost-effective nitrogen and protein determination in just five minutes. The use of argon instead of helium as carrier gas can make you independent of global helium supply issues. Helium is only recommended for special sample types which require detection limits in the lowest ppm range. The instrument offers a wide range of sample matrices thanks to the upright crucible design and unique post-combustion technology.

The user can measure up to 5 g of solid samples or 5 ml of liquid samples without additional materials or handling making sample preparation simple. Even with inhomogeneous samples such as fruit juices and burgers the analyzer yields accurate and reproducible results. In terms of maintenance effort, the analyzer comes with a user-friendly clamp connections system that ensures a tool-free maintenance.

Working principle of the rapid MAX N exceed

The crucibles with the samples are introduced to the combustion furnace by a gripper arm which includes the oxygen inlet. By dosing the oxygen directly at the sample, less oxygen is required for complete combustion, which is a key aspect of the unrivaled low price-per-sample. Due to the innovative EAS REGAINER® technology, more than 1,000 samples can be run without the need to exchange the reducing agent. Additionally, our plug-and-play pre-filled EAS REDUCTOR® tube used for reduction and the optional plug-and-play pre-filled EAS COMBUSTOR tube used for post-combustion save valuable time and ensure complete combustion. Once the sample is completely

converted into gas the water and other gases are removed from the gas stream. CO_2 is removed by alternating traps to decrease run time. The sample's nitrogen is then detected by a thermal conductivity detector. The nitrogen signal from this detector is visualized as a peak in the analyzer software, which translates the peak area into an absolute nitrogen amount.

The analyzer is designed for 24/7 automated operation and its software offers full control of the instrument and LIMS integration. For manufacturers who need to be compliant with GMP guidelines the rapid MAX N exceed can be delivered audit-ready via documents for swift analyzer qualification and a 21 CFR part 11 compliant software option. Thus, it meets requirements of the food tech industry.

Did you know?

As an alternative to the rapid MAX N exceed, many plant-based protein samples can be determined with the same accuracy on the rapid N exceed® analyzer. The analyzer differs in the maximum sample weight, sample preparation, carrier gas options and recommended sample homogeneity. Samples up to 1.5 g or 400 mg organics (depending on the sample matrix) are wrapped in tin foil and the instrument is equipped with a standard 60-position carousel instead of a 90-position carousel. With CO_2 as carrier gas and the EAS REDUCTOR lasting for up to 2.000 samples, the rapid N exceed offers even lower cost per sample. Budget-oriented users opt for the rapid N exceed whereas users who need simplified sample preparation and feeding as well as a high throughput opt for the rapid MAX N exceed.

Results

To demonstrate precision and flexibility of the rapid MAX N exceed for alternative protein analysis, various plant-based protein powders as well as milk, sausage, and burger analogues from different protein sources were analyzed in six replicates. The samples were put directly into the upright crucibles. All samples were measured with helium as carrier gas, with standard settings and tube fillings. The nitrogen content of the samples was multiplied by the protein factor of 6.25 to determine the protein content.

The four types of protein powders from soy, pea, hemp, and rice were all measured with an absolute standard deviation (SD) of <0.03% for the homogeneous samples with a protein content of up to 87%. For the liquid oat drink and the cheese analogue the measurement results demonstrate the high-quality instrument performance. If you apply the EN ISO 14891 norm for milk (SD 0.015% N) and cheese (SD 0.2% N), the standard deviation for both measurements (see tables 5 and 6) is many times lower than required by the norm. The sausage analogue measurements show high precision with an SD of 0.014%. Finally, the protein burger analogue as highly inhomogeneous original sample without special preparation was measured with an SD of 0.15%.

Table 1. Results for soy protein isolate samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 1 SOY PROTEIN ISOLATE	replicate 1	13.951	87.19	0.2	glutamic acid
	replicate 2	13.966	87.29		
	replicate 3	13.983	87.39		
	replicate 4	13.932	87.08		
	replicate 5	13.981	87.38		
	replicate 6	13.917	86.98		
	average value	**13.955**	**87.22**		
	absolute standard deviation	**0.027**	**0.17**		
	relative standard deviation	**0.192**	**0.19**		

Table 2. Results for pea protein isolate samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 2 PEA PROTEIN ISOLATE	replicate 1	13.299	83.12	0.2	glutamic acid
	replicate 2	13.277	82.98		
	replicate 3	13.307	83.17		
	replicate 4	13.290	83.06		
	replicate 5	13.289	83.06		
	replicate 6	13.288	83.05		
	average value	**13.292**	**83.07**		
	absolute standard deviation	**0.010**	**0.07**		
	relative standard deviation	**0.078**	**0.08**		

Table 3. Results for hemp nut protein powder samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 3 HEMP NUT PROTEIN POWDER	replicate 1	8.853	55.33	0.2	glutamic acid
	replicate 2	8.805	55.03		
	replicate 3	8.836	55.22		
	replicate 4	8.826	55.17		
	replicate 5	8.822	55.14		
	replicate 6	8.833	55.20		
	average value	**8.829**	**55.18**		
	absolute standard deviation	**0.016**	**0.10**		
	relative standard deviation	**0.181**	**0.18**		

Table 4. Results for rice protein powder samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 4 RICE PROTEIN POWDER	replicate 1	13.642	85.26	0.2	glutamic acid
	replicate 2	13.616	85.10		
	replicate 3	13.611	85.07		
	replicate 4	13.622	85.14		
	replicate 5	13.647	85.29		
	replicate 6	13.617	85.11		
	average value	**13.626**	**85.16**		
	absolute standard deviation	**0.015**	**0.09**		
	relative standard deviation	**0.109**	**0.11**		

Table 5. Results for oat drink samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 5 OAT DRINK	replicate 1	0.178	1.12	1.5	milk
	replicate 2	0.176	1.10		
	replicate 3	0.173	1.08		
	replicate 4	0.176	1.10		
	replicate 5	0.174	1.09		
	replicate 6	0.174	1.09		
	average value	**0.175**	**1.10**		
	absolute standard deviation	**0.002**	**0.01**		
	relative standard deviation	**1.161**	**1.16**		

Table 6. Results for walnut cheese analogue samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 6 WALNUT CHEESE ANALOGUE WITH POTATO PROTEIN	replicate 1	0.085	0.53	0.5	cheese
	replicate 2	0.088	0.55		
	replicate 3	0.086	0.54		
	replicate 4	0.086	0.54		
	replicate 5	0.087	0.54		
	replicate 6	0.085	0.53		
	average value	**0.086**	**0.54**		
	absolute standard deviation	**0.001**	**0.01**		
	relative standard deviation	**1.325**	**1.33**		

Table 7. Results for sausage analogue samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 7 SAUSAGE ANALOGUE FROM PEA AND SOY PROTEIN	replicate 1	1.279	7.99	0.5	sausage
	replicate 2	1.311	8.19		
	replicate 3	1.305	8.16		
	replicate 4	1.282	8.01		
	replicate 5	1.296	8.10		
	replicate 6	1.310	8.19		
	average value	**1.297**	**8.11**		
	absolute standard deviation	**0.014**	**0.09**		
	relative standard deviation	**1.079**	**1.08**		

Table 8. Results for burger analogue samples

		N [%]	PROTEIN [%]	SAMPLE WEIGHT [g]	METHOD
SAMPLE 8 BURGER ANALOGUE FROM PEA AND RICE PROTEIN	replicate 1	2.627	16.42	0.5	meat
	replicate 2	2.709	16.93		
	replicate 3	2.738	17.12		
	replicate 4	2.585	16.16		
	replicate 5	2.465	15.41		
	replicate 6	2.907	18.17		
	average value	**2.672**	**16.70**		
	absolute standard deviation	**0.151**	**0.94**		
	relative standard deviation	**5.641**	**5.64**		

Summary

The rapid MAX N exceed is a flexible and highly automated solution for the determination of protein content in plant-based food. The analytical performance leads to excellent results at every step in the plant-based protein supply chain, from analyzing plants over new food-tech ingredients to quality control of end consumer products as meat and dairy analogues. The measurement results highlight the broad applicability of the instrument by the low RSD of different alternative protein products with varying protein sources and sample sizes. Compared to Kjeldahl, the Dumas combustion method of Elementar's N/protein analyzers offers higher throughput, lower operating cost, ease of use and is environmentally friendly. The alternative budget oriented rapid N exceed is the clear choice among start-ups and young companies in the emerging plant-based food industry.

Elementar – your partner for excellent elemental analysis
Elementar is the world leader in high performance analysis of organic and inorganic elements. Continuous innovation, creative solutions and comprehensive support form the foundation of the Elementar brand, ensuring our products continue to advance science across agriculture, chemical, environmental, energy, materials and forensics markets in more than 80 countries.

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