



Agri - Food



Chemicals



Geo - Environment



Energy

Application Note

Nitrogen/Protein in food samples

Instrument: ECS 8024

Mode: N or CN



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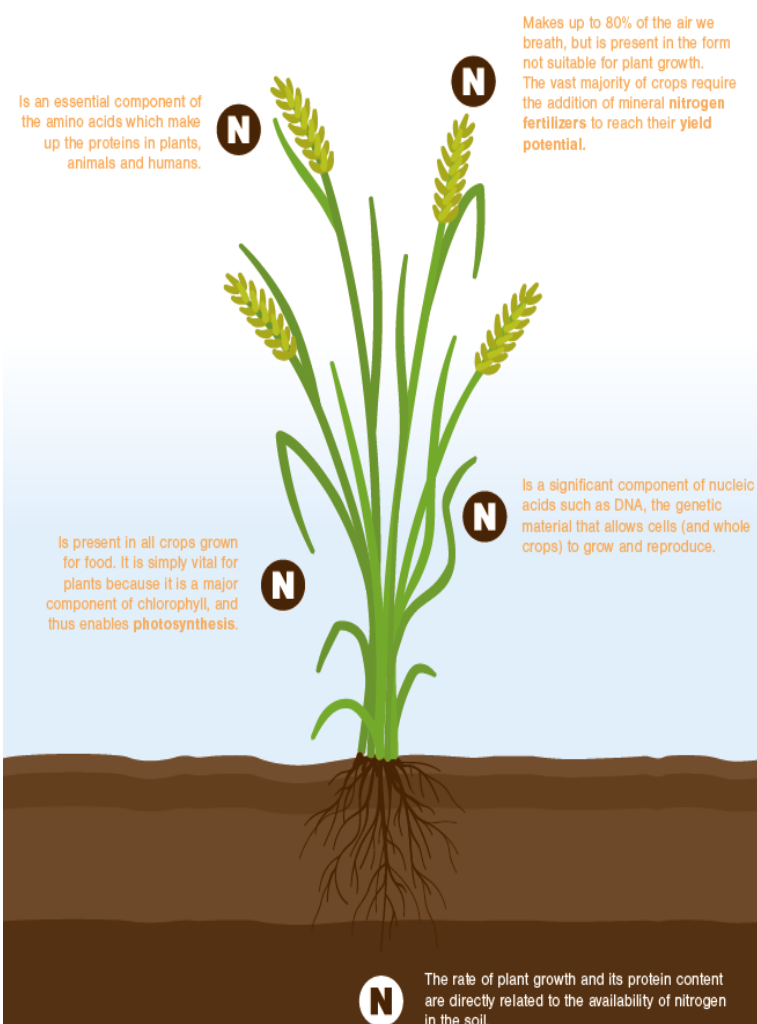
NC TECHNOLOGIES

Innovative Elemental Analysis

Application Note – Nitrogen/Protein in food samples

Nitrogen: an important element in the food system

The food system has to provide food security with healthy, accessible, affordable, safe and diverse food for all, and it has to do so within the safe operating space of the planetary boundaries, where the pollution from reactive nitrogen turned out to be the largest bottleneck.



A food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes.

Nitrogen is an essential building block for the whole food system from farm to mouth. For food production, both under- or oversupply of nutrients are problematic. An unbalanced nitrogen cycle causes an environmentally unsustainable food system, resulting in air and water pollution, affecting soil quality, and contributing to climate change or biodiversity loss.

Nitrogen is a main body component and is required for both tissue protein synthesis and the production of several nitrogenous compounds involved in a variety of functions (hormones, immune mediators, neurotransmitters, antioxidant defences, etc.). Thus, the body nitrogen content should be both quantitatively and qualitatively normal, as well as normally maintained, to ensure normal body functions.

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Protein requirements

Dietary requirements for protein, amino acid and nitrogen depend on the metabolic demand that must be satisfied.

Protein quality in turn depends on the amount of essential amino acids (EAA), but also of the non-essential (NEAA) ones. The link between protein quality and EAA is obvious: since the EAA cannot, by definition, be synthesized by the body, they must be introduced with the diet in a proportion that will fit with the organism's metabolic needs.

Nitrogen is an important part of your diet, as it is a critical component of amino acids, the proteins they form, and nucleic acid, including DNA and RNA. We consume it from proteins, and it helps build muscles, repair tissues, and regulate hormones, according to research.

Our bodies cannot store amino acids for later use, so we eat protein in our diet daily to remain healthy.

It's important to know which foods are rich in nitrogen as you build a healthy diet.

There are quite a few foods that are rich in nitrogen, for example:

- ❖ meat
- ❖ fish
- ❖ vegetables
- ❖ fruits
- ❖ milk and dairy foods
- ❖ beans
- ❖ eggs
- ❖ fibers



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Elemental analysis

Element analysis methods have been actively developed during the recent decades. Generally, an element analysis can be considered as a two-step process: the first step, ie the preparation step, is aimed at eliminating organic matters and the second step at quantifying the elements.

The sample preparation

Simple preparation is of great importance for element analysis since it may dramatically influence the results. Many factors should be considered while choosing sample preparation such as the concentration range of the targeted elements, the detection technique, the sample homogeneity, the contamination level, the time and labor investment, and the reagent consumption.

The key to success

The homogeneity of the sample is the key to obtaining good results, regardless of which analytical technique is used.

The following are the steps to prepare an analysis:

- sample preparation
- sample weight
- calibration of the detector
- selecting measurement conditions correctly
- assessment and evaluation of the results

Why do we use tin foil?

Tin combusts strongly exothermic to tin(IV)oxide. The energy released during that process supports the full combustion of the sample.

Tin foil is used in sample weighing and sample tablet are made from this which are then kept in the sample tray until analysis.

The foil wrapped samples are placed in the sample tray and the autosampler is then closed with the cover plate before analysis.



Autosampler with purification system from atmospheric nitrogen.



Samples wrapped into tin foil

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The elemental analyser

While the acid digestion according to the Kjeldahl method destroys the sample in a rather rustic way, combustion provides a somewhat more elegant and time saving alternative. The sample is oxidised in a controlled way and the resulting gaseous products are subjected to further analysis. The objective is the complete conversion of the sample into the primary products carbon dioxide, water and nitrogen dioxide, without the secondary products carbon monoxide (CO) and nitrogen monoxide (NO) being produced by incomplete combustion.

As air has a nitrogen content far in excess of 70 %, the key to success here is effective sealing against the ambient air in combination with an efficient purging function. An efficient autosampler is needed so that interaction of the sample and air is ruled out.



ECS 8024 elemental analyser

The ECS 8024 elemental analyser is based on the classic principle of combustion analysis according to Jean Dumas , almost maintenance-free operation is possible with modern control software.

The pneumatic autosampler feeds the solid or liquid samples packed in tin foil to the combustion furnace. At the same time, the helium gas flow is changed over to oxygen to initiate the combustion. The sample incinerates and the ash produced is collected in the ash insert. The gaseous combustion products react completely in the presence of catalysts to the required oxides and are transported through the machine by a helium flow after combustion. The nitrogen oxides are first reduced to elementary nitrogen in the reduction reactor while the secondary products, water and carbon dioxide, are separated in special traps. A gas flow consisting helium and nitrogen remains, from which the nitrogen can be measured using a thermal conductivity detector. Computer-control enables simultaneous evaluation of the analysis data.

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Some examples

In these examples, we have reported some analyses carried out on different types of foods, both liquid and solid.

In particular, we analyzed the nitrogen concentration in soy sauce, cheese (Parmesan), and wheat flour.

The interesting connection between biomolecules and nitrogen analysis is that nitrogen in foodstuffs and feedstuffs is only incorporated into these amino acid chains in proteins.

Determining the nitrogen content therefore provides a qualitative inference of the quantity of protein in the product, if the amino acid chain only contains a restricted number of the 20 amino acids in total. What is known as the protein factor makes it possible to calculate the protein content from the nitrogen content.

These protein factors have been specified and standardized in international conventions:

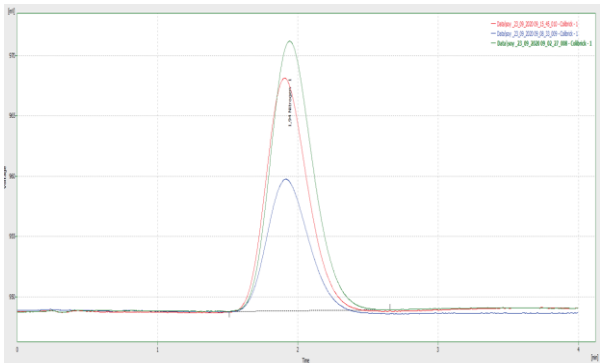
Type of sample	Protein factor
Milk and dairy products	6,38
Meat, meat products	6,25
Cereals and cereal products	6,25
Egg and egg products	6,25
Soya and soy products	6,25
Feedstuffs	6,25
Wheat and wheat products	5,7

The analytical method therefore consists in determining the nitrogen content, from which the protein content is determined mathematically:

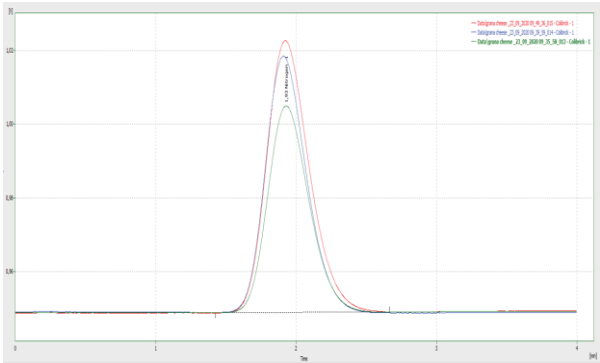
$$\begin{aligned} &\text{Protein content [\%]} \\ &= \text{nitrogen content [\%]} * \text{protein factor} \end{aligned}$$

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Sample	Weight (mg)	% N	Protein factor	%P
Soy sauce	16,61	1,24	6,25	7,75
Soy sauce	10,50	1,25	6,25	7,81
Soy sauce	18,18	1,26	6,25	7,88
Average		1,25		7,81
Std Dev		0,01		0,06
RSD %		0,80		0,80



Sample	Weight (mg)	% N	Protein factor	%P
Cheese	11,471	6,5	6,38	41,47
Cheese	10,523	6,46	6,38	41,21
Cheese	8,573	6,44	6,38	41,09
Average		6,47		41,26
Std Dev		0,03		0,19
RSD %		0,47		0,47



Sample	Weight (mg)	% N	Protein factor	%P
Wheat flour	15,48	1,62	5,7	9,23
Wheat flour	15,48	1,61	5,7	9,18
Wheat flour	15,11	1,59	5,7	9,06
Average		1,61		9,16
Std Dev		0,02		0,09
RSD %		0,95		0,95

