Gerhardt
Analytical Systems

C. Gerhardt compendium

THE SIGNIFICANCE OF NITROGEN ANALYSIS

Nährwertangaben	je 100 g
Brennwert	1344 kJ 320 kcal
Fett	5,5 g
davon gesättigte Fettsäuren	1,5 g
Kohlenhydrate	60,1 g
davon Zucker	26,3 g
Eiweiß	7,6 g
Salz	0,07 g

Bund für Lebensmittelrecht und Lebensmttelkunde e. V.

Fig. 1: Food pyramid and nutritional information in general

Food and animal feed of all kinds contain, as a matter of course, a wide variety of components. Protein is one of the most important components and is a fundamental factor in the price of a product.

Almost all food contains protein, in greater or lesser amounts. After analytical testing of products to establish their protein content, they are labelled with the relevant nutritional information. The daily total nutritional need determined for adults is about 2,000 kcal for women and about 2,500 kcal for men. This need is met with products from the food pyramid shown here. Products from the lower levels should be consumed frequently, while foodstuffs in the upper levels are consumed correspondingly less often.

The packaging of all food shows information about its nutritional values, which are now specified in European laws that prescribe mandatory labelling for all manufacturers.

The mandatory information includes data about protein, carbohydrates/sugars, fat, dietary fibre and sodium. Other information can be provided on a voluntary basis. Fig. 1 shows an example of a nutritional values label.

The following daily requirements have been determined (subject to age) for proteins, fats, dietary fibre and mineral nutrients:

Nutrient	Women	Men
Energy	2000 kcal	2500 kcal
Protein	50 g	60 g
Carbohydrates	270 g	340 g
Fat	70 g	80 g
Saturated fatty acids	20 g	30 g
Dietary fibre	25 g	25 g
Salt	6 g	6 g
Total sugar	90 g	110 g

If, for example, we analyse cereals to establish their main ingredients, we find approximately the following values for 100 g of product:

Name	Protein [g]	Fat [g]	Carbohydrates [g]	Iron [mg]	Magnesium [mg]	Potassium [mg]
Maize kernel	9.20	3.80	65.00	1.70	0.00	294.00
Rice grain	7.80	2.20	74.10	3.20	119.00	238.00
Wheat grain	11.40	1.80	61.00	3.30	97.00	381.00

Source: based on lebensmittellexikon.de, available online: http://www.lebensmittellexikon.de/g0000620.php

However, it is the protein content that primarily determines the market price.
How can this be quantitatively determined? To answer this question, we first have to clarify the following question: How does nitrogen get into the food or feedstuff?

Fig. 2 shows the natural nitrogen cycle. It shows how nitrogen in the soil, nitrogen in the air and sunlight form organic nitrogen in biomass. The cycle is then completed by livestock and humans through waste water and sewage treatment plants.

Nitrogen is transformed by a variety of natural organisms, which convert it into highly complex biomolecules, which makes determining the nitrogen content a complex process.
First, inorganic and organic nitrogen in the soil is converted into plant protein by the addition of water and light. Animal and plant proteins enter the human food chain, with the cycle now completed by analysing nitrogen that is once again inorganic in sewage and fertilizers.

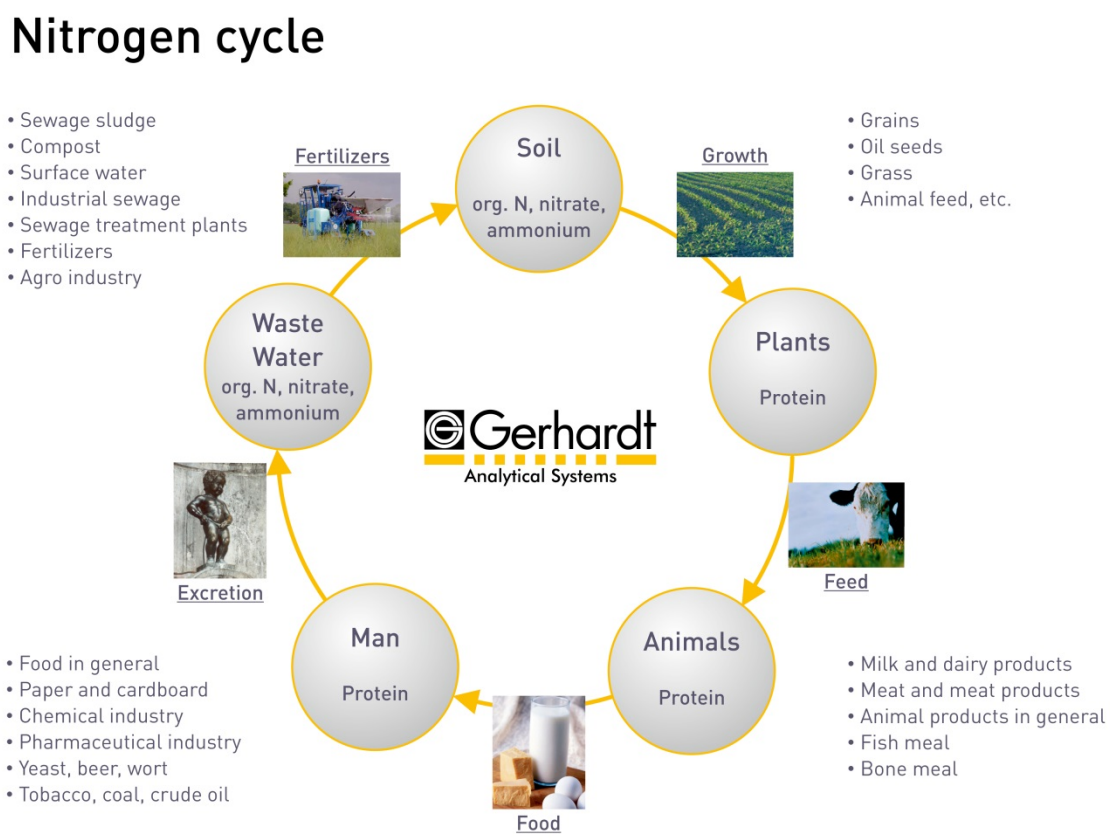

Fig. 2: The natural nitrogen cycle

These initially simple processes result in proteins, highly complex macromolecules consisting of multiple amino acid chains. To begin with, the basic structure is created by simple concatenation of amino acids by means of what is known as the peptide bond between the acid function and the amino group of the individual components. This results in sequences of amino acid chains (primary structure) that then clump together into more complex three-dimensional structures, e.g. when intermolecular hydrogen bonds lead to the well-known beta sheet or alpha helix structures (DNA). Given that there are 20 amino acids available, from a purely statistical point of view there is an almost infinite range of possible combinations.

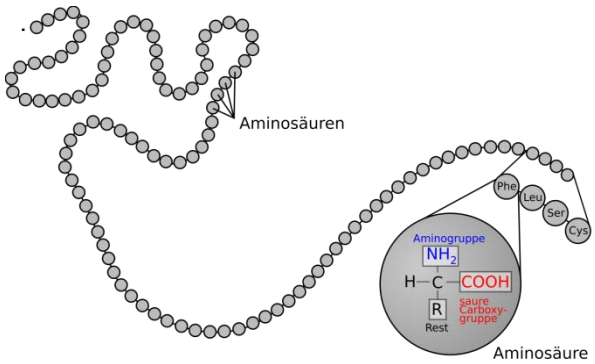

Fig. 3: Chain structure of proteins consisting of amino acids

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 standardised in international conventions (Fig. 4).

Sample	Protein factor
Milk and dairy products	6.38
Meat, meat products	6.25
Cereals and cereal products, except wheat and wheat products	6.25 5.7
Egg and egg products	6.25
Soya and soy products	6.25
Feedstuffs	6.25

Fig. 4: Protein factors for various sample types

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

Protein content [%]
= nitrogen content [%] * protein factor

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