

Plant-based proteins

Because of the positive effect on health and the environment, there is an increasing focus on plant-based foods. The shift from a more animal-based to a more plant-based diet means that plant protein is becoming a more important part of the diet. While sugar beet is known as an important source of sugar, plant protein can also be extracted from the leaves of sugar beet. This fact sheet discusses the importance of protein in the diet, protein quality, the shift to a more plant-based diet, important plant protein sources, the dietary reference values for protein determined by the Health Council of the Netherlands, current protein consumption in the Netherlands and the use of plant protein for athletes.

What is protein?

Protein is a macronutrient just like carbohydrates and fat. Protein is important for maintaining and building muscles and bones, producing enzymes, the immune system and transporting substances within and between cells¹. In addition, proteins also provide energy (4 kcal per gram). Proteins in our diet can come from animal and plant foods, such as meat, fish, dairy, eggs, nuts, grains and legumes.

Proteins are made up of hundreds or thousands of smaller building blocks: the amino acids. A total of 22 different amino acids are important for the human body. The properties of a protein are determined by the number of amino acids, the order in which amino

acids are connected and the way they are connected. In the gastrointestinal tract, protein is broken down into the individual amino acids and absorbed into the body. There, these amino acids are used again to make new proteins.

Amino acids can be divided into three categories:

1. Essential amino acids
2. Conditionally essential amino acids
3. Non-essential amino acids

Essential amino acids are amino acids that the human body cannot produce itself, and which must be obtained through the diet. Conditionally essential amino acids are amino acids that the body cannot produce sufficiently on its own in certain circumstances (e.g. some conditions and diseases). In that case, these amino acids must be supplemented through the diet. Non-essential amino acids are amino acids that the body can produce itself from other amino acids. **Table 1** lists the essential, conditionally essential and non-essential amino acids.

Table 1. Overview of essential, conditionally essential and non-essential amino acids².

Essential amino acids	Conditionally essential amino acids	Non-essential amino acids
Histidine	Arginine	Alanine
Isoleucine	Asparagine	Aspartic acid
Leucine	Glutamine	Cysteine
Lysine	Glycine	Cystine
Methionine	Serine	Glutamic acid
Phenylalanine	Proline	Tyrosine
Threonine		Hydroxyproline
Tryptophan		

Protein Quality

The quality of protein in a food depends on a number of criteria³:

1. The amount of protein in the food;
2. The amount of essential amino acids in the protein;
3. The extent to which the protein is digested in the gut and the absorption of the released amino acids by the body.

See the text box on this page on how to determine protein quality.

Typically, the protein quality of plant products is lower than that of animal products. This is generally caused by the fact that in many plant products, certain essential amino acids are only present in limited amounts or are completely absent. In addition, the bioavailability of protein in plant sources is limited by the presence of so-called anti-nutritional factors. These anti-nutritional factors negatively affect the digestion and absorption of amino acids^{4,5}. Product processing (e.g. cooking, soaking, fermentation) can improve bioavailability⁵.

Protein transition

There is an increasing focus on plant-based proteins. This is partly because of the positive effects of plant-based diets on health and the environment. In the Dutch dietary guidelines 2015⁹, the Health Council of the Netherlands recommends eating a more plant-based and less animal-based diet. The shift from animal to plant-based protein sources is also known as the "protein transition". The Council for the Environment and Infrastructure, the strategic advisory body for Dutch government and parliament on the broad domain of the physical environment, advised in 2018 that food policy should aim for a ratio of 40% animal and 60% plant protein consumption by 2030; this because of climate goals. Currently, this ratio is about 60% animal and 40% plant protein¹⁰. The Netherlands Nutrition Centre calculated that when eating according to the Wheel of Five, with a maximum of 500 grams of meat eaten per week, the ratio of animal and plant-based protein is 50/50. When no meat is eaten, but dairy, egg and fish are eaten, the ratio is 40% animal protein and 60% plant-based protein¹¹.

Determining protein quality

Several measures have been developed to calculate the quality of a protein. The Food and Agriculture Organisation of the United Nations (FAO) has recommended the use of the Digestible Indispensable Amino Acid Score (DIAAS) since 2011⁶. The DIAAS is determined by calculating the following ratio for each essential amino acid:

$$\frac{\text{Digestible essential amino acid in ileum (mg/g protein)}}{\text{Reference requirement (mg/g protein)}}$$

The lowest ratio is then multiplied by 100%. This value is the DIAAS.

Unfortunately, the DIAAS also has some limitations. For instance, currently most digestibility data are based on animal studies and the DIAAS focuses mainly on isolated protein sources and/or raw food. Cooking affects protein digestibility^{7,8}.

Protein from sugar beet

Besides proteins being found naturally in food, there is also increasing research into extracting proteins from residual products of food crops. These can be used to enrich products or make meat and/or dairy substitutes. One example is protein from sugar beet leaves. The leaves of plants, including sugar beet, contain the enzyme Ribulose-1,5-bisphosphate carboxylase oxygenase, also known as RuBisCo. This enzyme is crucial for photosynthesis and is one of the most abundant proteins on Earth¹². RuBisCo is interesting because it contains a high amount of essential amino acids. In addition, it can be used as an emulsifier, foaming and gelling agent and is a good plant-based alternative to chicken egg protein^{13,14}.

Sources of plant-based protein

Important sources of plant-based protein include cereals, nuts, pulses, tofu and tempeh. Between these plant-based protein sources there are large differences in the amount of protein (% of total raw material) and the amount of essential amino acids (% of total protein)¹⁵. In particular, the amount of the essential amino acids lysine and methionine appears to be lower in plant protein compared to animal protein. Among other things, lysine is used in the body for protein synthesis and the production of collagen and elastin (both are important for connective tissue)¹⁶. Methionine plays an important role in metabolism and the immune system, among others^{16,17}. In a plant-based diet, it's critical to consume more plant-based protein products and a wider variety of plant-based protein products to ensure that you're getting enough of all (conditionally) essential amino acids¹⁵.

Dietary reference values for protein

In 2021, the Health Council of the Netherlands published dietary reference values for protein¹. These are shown in **Table 2**. This advice did not specifically consider the increased protein need for people with vegetarian and vegan diets. This will be done in the future. Until then, the conversion factors from 2001 remain: for a vegetarian diet, the recommended amount of protein is 1.2x higher and for a vegan diet 1.3x higher than for a non-vegetarian/vegan diet.

Whether elderly people have a higher protein requirement is currently a matter of debate. Several experts say that the elderly need more protein because of the positive effect of increased protein intakes on, for example, muscle strength and physical functioning in (frail) elderly people¹⁸. However, the Health Council of the Netherlands saw no convincing evidence that a higher standard is needed for all elderly people, because extra protein is unlikely to have an effect on muscle strength if physical activity does not increase at the same time. Also, higher protein intake is unlikely to have an effect on physical functioning, according to the Health Council of the Netherlands¹.

Table 2. Dietary reference values for protein¹.

Age (years)	Recommended amount (g/kg/d)	
	Boys and Girls	
0.5	1.31	
1	1.14	
1,5	1.03	
2	0.97	
3	0.90	
4	0.86	
5	0.85	
6	0.89	
7	0.91	
8	0.92	
9	0.92	
10	0.91	
	Boys	Girls
11	0.91	0.90
12	0.90	0.89
13	0.90	0.88
14	0.89	0.87
15	0.88	0.85
16	0.87	0.84
17	0.86	0.83
	Men and Women	
18+	0.83	

Protein consumption in the Netherlands

On average, Dutch people (1-79 years) eat 78 grams of protein per day, of which 30 grams ($\pm 38\%$) are plant-based. When this total protein intake is calculated as intake per kilogram of weight, the average protein intake is 1.21 g/kg/day, which is above the protein standard from **Table 2**¹⁹. **Figure 1** shows plant-based and animal protein intake, based on the 2012-2016 food consumption survey¹⁹.

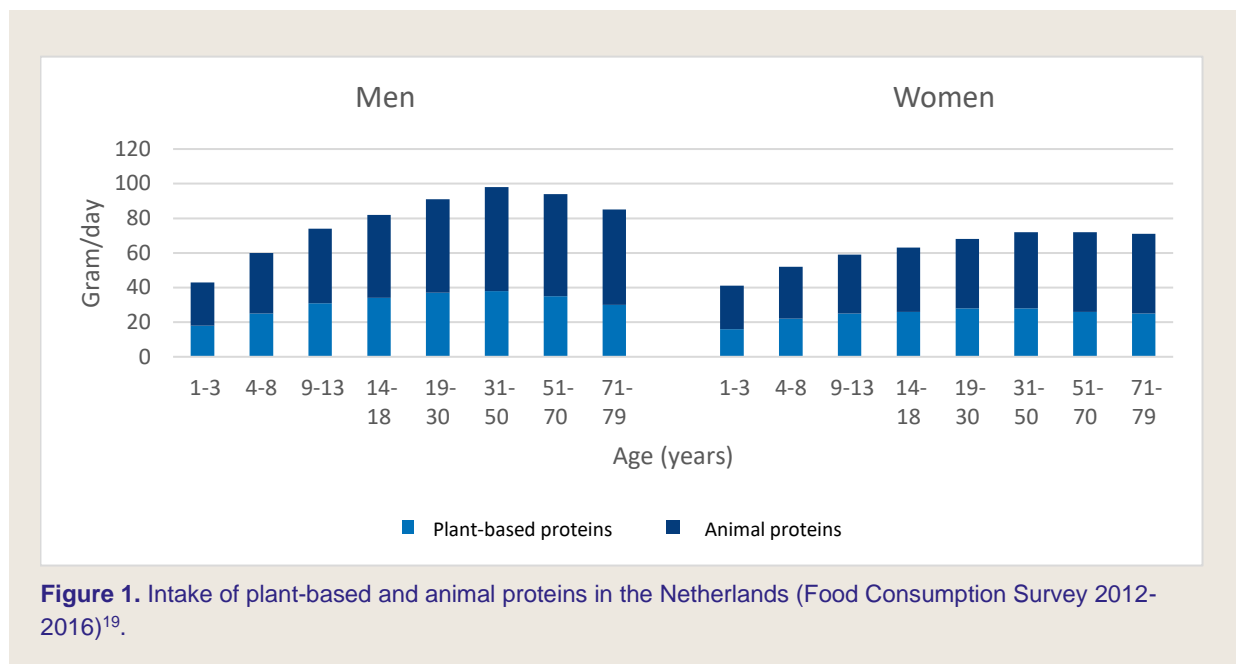


Figure 1. Intake of plant-based and animal proteins in the Netherlands (Food Consumption Survey 2012-2016)¹⁹.

The figure shows that protein intake for men and women increases until the age group 31-50. The share of plant protein is about 40% for men and women up to 50 years old, after that it drops to about 35%. The main source of plant protein is the product category bread, cereals, rice, pasta (56%), followed by fruits, nuts and olives (8%), and vegetables (7%)²⁰.

According to statistics, meat consumption has gone down slightly and sales of plant-based meat substitutes have risen sharply in recent years²¹.

Plant-based protein and sport

The protein transition has also made the use of plant-based protein an important topic for athletes. Protein is especially important in athletes because of muscle preservation and recovery. When it comes to protein intake it is important that athletes consume all the essential amino acids. Besides the previously mentioned lysine and methionine, the available amount of leucine is often relatively low in plant protein compared to animal protein. Leucine is important for athletes because it plays an important role in muscle protein synthesis. To get athletes to consume enough leucine from plant-based sources, there are several strategies: getting athletes to eat more plant-based protein; enriching (plant) food with leucine and possibly other essential amino acids; and selectively growing plants to improve the amount of amino acids and digestibility of the diet²².

Conclusion

The average protein intake in the Netherlands is above the protein reference values set by the Health Council of the Netherlands. About 40% of this protein intake comes from plant sources.

From a health and environmental perspective, this will have to increase further in the coming years. In a more plant-based diet, it is important to eat more plant-based protein products and eat a wider variety of plant-based protein products.

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