

# **Factsheet**

## **The role of potato (products) in a healthy and sustainable diet**



# Key messages

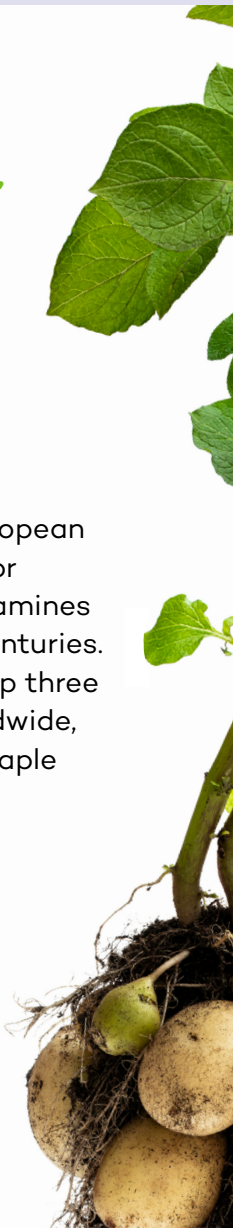
- After rice and wheat, potatoes are in the top three most widely available staple foods worldwide.
- Per 100 grams, potatoes contain around 19 grams of carbohydrates, mainly in the form of starch. They also provide fibre and a small amount of high-quality protein. In addition, potatoes contain vitamin C, B<sub>6</sub>, potassium, calcium, magnesium, and phosphorus.
- Potatoes (and potato products) are included in the Dutch Wheel of Five and international equivalents, such as the 'Chinese Food Guide' and the U.S. 'MyPlate'. Potato products are included in the Wheel of Five when prepared without salt or fat, or with fats included in the Wheel of Five, as long as they are not deep-fried.
- While potato consumption in the Netherlands is slightly declining, it is increasing in Asia. Consumption is also rising in Africa and Latin America, though to a lesser extent.
- The environmental impact of potatoes per kilogram is relatively low compared to other staple foods. Potato cultivation generates fewer greenhouse gas emissions and requires less land, water, and energy than rice and wheat.
- Potatoes are expected to play an increasingly important role in healthy and sustainable diets, significantly contributing to global food security.

**The potato (*Solanium tuberosum L.*<sup>1</sup>) is a nutritious and versatile root vegetable that, like tomatoes and peppers, belongs to the nightshade family. This factsheet discusses, among other things, potato cultivation, nutritional value, health aspects, application, consumption, and ecological footprint of potatoes and potato products.**

## A bit of history

The potato originates from the Andes. The Spanish brought this root vegetable from South America in the mid-16<sup>th</sup> century. Around 1600, the potato was introduced to the Netherlands as a rare garden plant. It wasn't until the 18<sup>th</sup> century that potatoes began to be seen as a food source. As a result, it was only in the 19<sup>th</sup> century that European populations started eating potatoes<sup>2</sup>. Due to their high nutritional value and ease of cultivation, potatoes quickly became the

most important food source in the European diet. Failed harvests caused by pests or diseases in the crop led to the worst famines Europe had experienced in previous centuries. Currently, potatoes rank among the top three most widely available food crops worldwide, following rice and wheat. They are a staple food in the diets of billions of people<sup>3</sup>.





## Potato cultivation

Potatoes grow underground as part of the potato plant. They are grown from seed potatoes, specially cultivated potato tubers, which are typically planted in ridges during April or May. One potato plant can produce ten or more new tubers. Depending on the potato variety and the season, the seed potatoes are harvested after four to five months, stored, and cooled. They are then sorted by size and checked for quality. In spring, these new tubers are replanted and multiplied into seed potatoes or potatoes for consumption<sup>2, 4</sup>. Potatoes for consumption, also known as table potatoes or fries potatoes, are harvested in autumn and stored until needed by processors (e.g., the potato processing industry, wholesalers, and supermarkets)<sup>2</sup>.

There are thousands of potato varieties worldwide. The diversity of varieties exists because different characteristics are required in cultivation areas in the Netherlands, Europe, and globally. Additionally, the potato processing industry and consumers use potatoes for various purposes, which requires specific properties of the potato. For example, slightly floury potatoes are used for making fries, while floury potatoes are used for dishes like mashed potato dishes<sup>5</sup>. Furthermore, potato granules and flakes are used as ingredients in other products such as soups and chips.

# The potato and health

## Nutritional value

### Macronutrients and energy content

Potatoes, like bread, pasta, and rice, are an important source of carbohydrates. Per 100 grams, they contain approximately 19 grams of carbohydrates, primarily in the form of starch. Potatoes also contain around 2 grams of dietary fibre per 100 grams (mostly in the peel), 2 grams of protein, and no fat. The remaining 77% of a potato consists of water<sup>6</sup>. Boiled potatoes provide about 83 kcal per 100 grams (see **Table 1**).

Dietary fibre has a positive effect on health. It promotes good digestion, provides a feeling of satiety after eating, and reduces the risk of type 2 diabetes, cardiovascular disease, and colon cancer<sup>7</sup>. Fibre in potatoes is mainly found in the peel. Potatoes can be eaten with

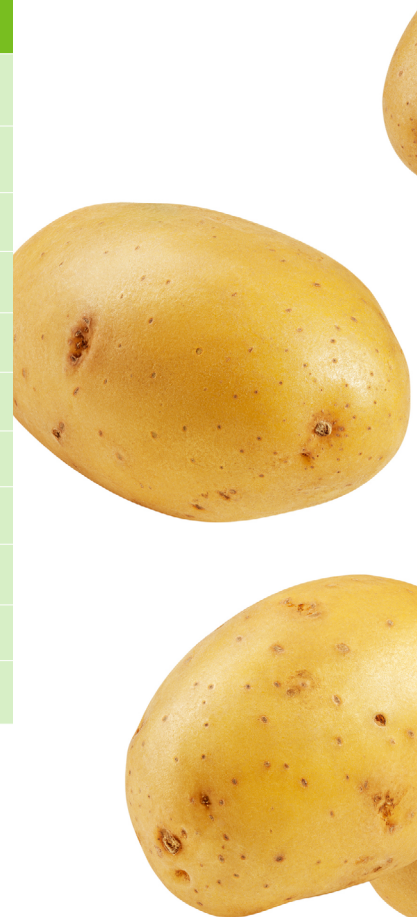
the skin, but it is important to remove sprouts, bruised or brown spots, and green areas generously. The peel also ensures that soluble vitamins do not dissolve in water and remain in the potato during cooking<sup>8</sup>.

Potatoes naturally contain resistant starch. Cooking or baking potatoes converts resistant starch into digestible starch, which can be broken down by digestive enzymes in the gut. However, cooling potatoes after cooking partially transforms some of the starch back into resistant starch. Resistant starch is not digested in the small intestine but is instead fermented as dietary fibre in the large intestine<sup>9</sup>.

**Table 1.** Energy content (kcal) of various carbohydrate sources per 100 grams<sup>6</sup>.

Food item, preparation method	Energy content (kcal) per 100 g
Potatoes, boiled	83
Potatoes, baked	119
Mashed potatoes, prepared	83
French fries, deep-fried in liquid fat	264
Oven fries, prepared*	292
Rösti	234
Sweet potato, boiled	63
Pasta, cooked	149
Rice, cooked	145
Wholemeal bread	140
White bread	249

\* During the preparation of oven-baked fries, a lot of water evaporates, resulting in more potato content and thus a higher energy content per 100 g of the product.



## Potato protein

The protein content in potatoes is relatively low, but of high quality. Potatoes have a DIAAS (Digestible Indispensable Amino Acid Score) of 100. This means that the protein in potatoes contains all the essential amino acids in a balanced ratio, which can be efficiently used by the body to build and maintain muscles, tissues, and enzymes<sup>10</sup>. A DIAAS of 100 is comparable to proteins from high-quality animal sources, such as milk (casein) and egg protein, which have a DIAAS of 100 or higher<sup>10</sup>.

Research on the effect of potato protein intake on muscle protein synthesis showed that the consumption of 30 g of potato protein concentrate increased muscle protein synthesis at rest and during recovery after exercise in healthy young men. Moreover, the rate of muscle protein synthesis after the intake of 30 g of potato protein was equivalent to the intake of 30 g of milk protein<sup>11</sup>.

## Micronutrients

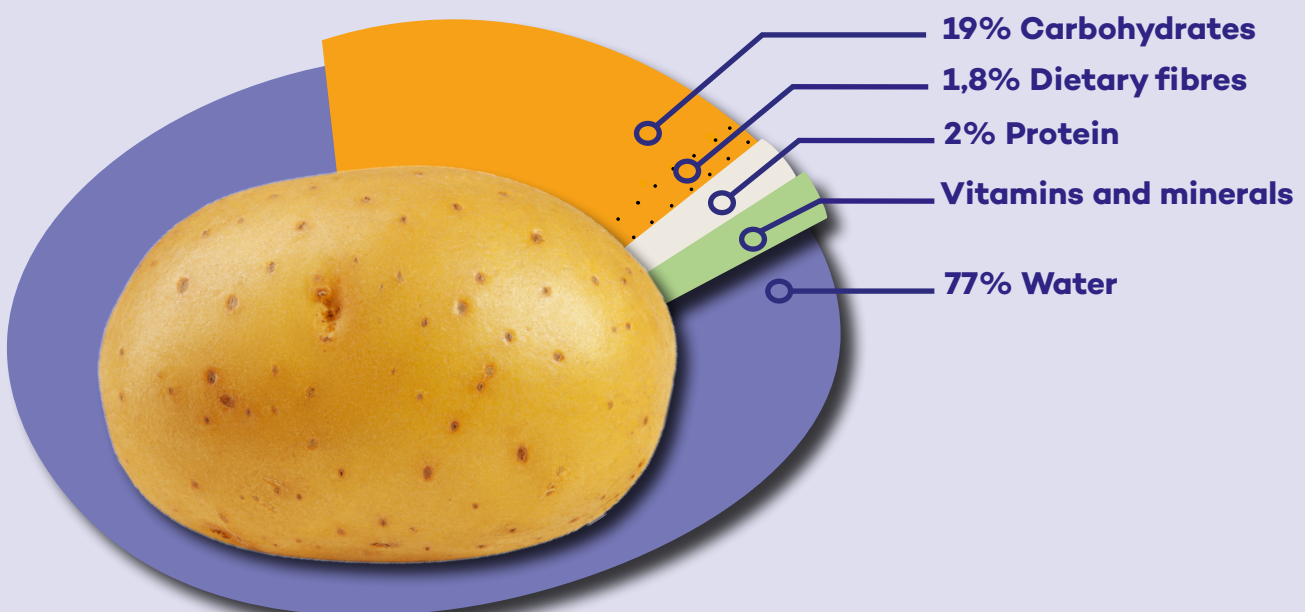
Potatoes contain micronutrients that are essential for healthy nutrition. Per 100 grams, they contain 14 mg of vitamin C. New and raw potatoes have a higher vitamin C content than older potatoes. Potatoes also provide 0.3 mg of vitamin B<sub>6</sub> per 100 grams, as well as smaller amounts of other B vitamins. Additionally, they contain potassium (450 mg per 100 g) and lower amounts of calcium (6 mg per 100 g), magnesium (22 mg per 100 g), and phosphorus (60 mg per 100 g)<sup>6</sup>. During preparation, the vitamin content of potatoes may decrease due to the effects of heat or the dissolution of vitamins into the cooking water.

**Table 2.** Population Reference Intake (PRI)\* of Vitamin C and Vitamin B<sub>6</sub> for adults<sup>12,13</sup>.

	PRI women (>18 years)	PRI men (>18 years)
Vitamine C	95 mg/day	110 mg/day
Vitamine B <sub>6</sub>	1.6 mg/day	1.7 mg/day

\* The Population Reference Intake (PRI) is the intake of a nutrient that is likely to meet the needs of almost all healthy people in a population.

**Figure 1.** The nutritional composition of the raw potato.



### The potato as part of a healthy diet

Boiled potatoes have a high nutrient density without providing excessive energy. They contain carbohydrates, dietary fibre, and various micronutrients<sup>14</sup>. Potatoes therefore contribute to the intake of several nutrients. The recommendation is to cook, steam, or bake them in oil or fat rich in unsaturated fatty acids. Additionally, it is important to combine them with other nutritious foods and not add too much salt<sup>3</sup>.

### Dietary guidelines potatoes (and potato products)

In the Dutch Wheel of Five, potato products (e.g., potatoes, baby potatoes, and slices) without salt, prepared without cooking fat or with cooking fats from the Wheel of Five, as long as they are not fried, are included. Examples of cooking fats in the Wheel of Five are liquid margarine and most vegetable oils, such as olive oil and sunflower oil<sup>15</sup>. These potato products are included in the Wheel of Five because they are a good source of carbohydrates and other nutrients. They are an addition to bread and grain products. The category 'bread, cereals, and potatoes' includes all whole grain varieties of bread and grain products. Additionally, potatoes are included in the Wheel of Five because they are a good addition, providing nutrients such as fibre, vitamin C, and vitamin B<sub>6</sub><sup>16</sup>.

Potato consumption is also recommended in other countries and is therefore included in the guidelines for a healthy dietary pattern. However, the classification in foreign versions of the Wheel of Five may differ. In some countries, potatoes are considered a vegetable due to their various vitamins and minerals, which are not found in grain products like pasta and rice<sup>4</sup>. For example, the American 'MyPlate' includes potatoes in

the vegetable category<sup>17</sup>. The same applies to France and Switzerland<sup>18</sup>. The Belgian 'Food Pyramid'<sup>19</sup>, the UK 'Eatwell Guide'<sup>20</sup> and the 'Chinese Food Guide'<sup>21</sup> group potatoes with (whole grain) cereals, just like in the Netherlands. In the Belgian 'Food Pyramid', potatoes are placed in the dark green category, which includes foods recommended for a healthy and environmentally-conscious dietary pattern. In various cohort studies, potatoes are not considered vegetables due to differences in nutrient density compared to other vegetables, their glycaemic index, and the likelihood that they are processed into fast food<sup>14</sup>.

Ready-made mashed potatoes, mashed potato powder, and fried products such as fries are not included in guidelines like the Wheel of Five. Although potatoes themselves fit into a healthy diet, these processed potato products are often prepared with more salt and (unhealthy) fats, leading to a higher fat content and more calories.



# Consumption of potatoes and potato products

## Applications of potatoes in food products

### **Potato products**

Potatoes are versatile and serve as the basis for a wide range of processed products available in supermarkets. These include potato croquettes, mash, slices, wedges, crisps, fries, and rösti. These products are often seasoned with a mix of herbs, spices, fats, and salt. Some are pre-baked or fried.

### **Potato as a functional ingredient in food**

Potato starch is widely used as a functional ingredient in food products due to its high starch content, primarily composed of complex carbohydrates such as amylose and amylopectin. The higher amylopectin content in potato starch contributes to a thicker texture, making it suitable as a binding or thickening agent in products like sauces, soups, and baked goods.

Moreover, potato starch is gluten-free, making it an excellent choice for gluten-free products. Its texture and binding properties ensure a soft consistency and support the rising process in bread and pastries, a common challenge in gluten-free baking.



## Consumption data

### Consumption in the Netherlands

In the Dutch National Food Consumption Survey (DNFCS), potatoes, potato products, and starchy root vegetables (such as sweet potato and cassava) are grouped under 'Potatoes'. According to the DNFCS 2019–2021, Dutch people consume an average of 64 grams per day from this group, three days a week<sup>22</sup>. Potato consumption in the Netherlands is declining. According to the DNFCS 2012–2016, the average daily consumption of potatoes was approximately 72 grams<sup>22</sup>.

Potatoes are predominantly eaten as part of warm (evening) meals, accounting for about 93% of daily potato consumption. Outside the home, the 'Potatoes' group is most commonly consumed in restaurants compared to other settings such as on-the-go locations, outdoor areas, schools, or workplaces.

### International consumption

Potatoes (products) are part of the diet of roughly two-thirds of the global population, amounting to an annual consumption of over 50 kilograms per person<sup>3, 23</sup>. While potato consumption is decreasing in the Netherlands, global demand is rising. Potato production is increasingly shifting to developing countries, especially in Asia, where both production and cultivation areas are rapidly expanding. Both the cultivation and consumption of potatoes are promoted by the government in China. This policy supports food security and farmer incomes, while reducing environmental impact through more efficient land and water use<sup>24</sup>. Production is also increasing in Africa (particularly East Africa) and Latin America, but to a lesser extent<sup>23, 25</sup>. These trends can be explained by new technologies, improvements in post-harvest production and infrastructure, government policies, and the favourable characteristics of potatoes. In addition, the shift towards more varied dietary patterns and the extra income from potato production play an important role<sup>26</sup>.

## Food safety

### Crop protection products

Crop protection products are used during potato cultivation and storage. During cultivation, these can be applied to prevent potato diseases. *Phytophthora infestans*, the causative agent of 'potato blight', is an example of a pathogen that can cause significant damage in the crop. Potatoes can be made more resistant to diseases and pests through plant breeding techniques. This is important because it can reduce the use of crop protection products worldwide and minimise economic losses<sup>27</sup>.

In storage, sprout inhibitors are sometimes used to help preserve potatoes.

The Netherlands Food and Consumer Product Safety Authority (NVWA) regularly checks that the residues of crop protection products left on food crops remain within legal limits. These limits are set to ensure the safety of consumption<sup>4</sup>. The likelihood of such residues posing a health risk is very low<sup>28</sup>.

### Acrylamide

Acrylamide can form when starchy products are heated above 120°C, for example, during frying or baking in the oven. Acrylamide may therefore be present in products like fries, crisps, coffee, breakfast cereals, and (especially toasted) bread. High intake of the substance can be harmful to humans and is suspected of being carcinogenic. By eating a varied range of foods and, for example, not baking potato products too brown, high intake of acrylamide can be prevented<sup>4, 29</sup>.





## The potato and sustainability

### Potato cultivation

Compared to other staple foods, potato cultivation has a relatively low impact on climate change, soil, water, land, and energy use (see **Table 3**)<sup>30</sup>. This is especially true in comparison to rice. Additionally, cultivation has a relatively low impact on acidification, eutrophication, and water use. This means that potatoes make efficient use of nitrogen, phosphate, and water. As a result, there is less soil acidification and lower greenhouse gas emissions per kilogram of potatoes produced compared to rice and wheat. Furthermore, potatoes produce more product per litre of

water. This low water usage is beneficial for cultivation in water-scarce areas. Potatoes also have higher yields of edible product per hectare, leading to more efficient land use. Due to this more efficient land use, pressure on available agricultural land is reduced, and cultivation contributes to the preservation of biodiversity, as less land is required for monoculture and more space is available for diverse crops and natural ecosystems<sup>23, 30, 31</sup>.



**Table 3.** The National Institute for Public Health and the Environment (RIVM) has examined the environmental impact of approximately 400 food products and provided figures to shed light on the impact of consumption in the Netherlands. This table shows the environmental impact of potatoes, rice, and pasta based on different environmental indicators (greenhouse gas emissions, soil acidification, eutrophication of fresh and saltwater, land use, and blue water use (irrigation water)). The foods were compared for '1 kg of food consumed by the Dutch consumer and sold through a Dutch supermarket'<sup>30</sup>.

	Greenhouse gas emission	Soil acidification	Eutrophication freshwater	Eutrophication saltwater	Land use	Blue water use
	kg CO <sup>2</sup> eq	kg SO <sup>2</sup> eq	kg P eq	kg N eq	m <sup>2</sup> /a crop eq	m <sup>3</sup>
<b>Up to distribution</b>						
Potatoes without peel	0.27	0.0017	0.00002	0.0008	0.25	0.01
Rice, white	3.04	0.0061	0.00065	0.0016	2.66	0.40
Pasta (wheat)	1.47	0.0071	0.00069	0.0023	1.53	0.02
<b>Up to retail</b>						
Potatoes without peel	0.34	0.0019	0.00026	0.0008	0.27	0.01
Rice, white	3.15	0.0063	0.00067	0.0016	2.72	0.40
Pasta (wheat)	1.55	0.0073	0.00072	0.0024	1.56	0.02
<b>Up to consumption</b>						
Potatoes without peel	1.15	0.0035	0.00061	0.0012	0.40	0.02
Rice, white	2.39	0.0042	0.00059	0.0009	1.56	0.24
Pasta (wheat)	1.97	0.0044	0.00072	0.0012	0.76	0.02

\* The RIVM dataset is based on average figures of the environmental indicators. It is important to remember that the figures vary at each stage of the food chain (e.g. per potato processor and per consumer).

## Potato processing industry

The environmental impact of processing potatoes into products such as crisps, chips, and potato starch mainly comes from energy and water consumption during storage and production processes. Water is used in the potato sector for washing, transporting, steam peeling, cutting, and blanching potatoes. Additionally, water is used to cool machines and equipment involved in the processing of potatoes and to clean the processes. In recent years, many steps have been taken to reduce water usage, including reusing water as cooling water and for cleaning processes. Renewable energy sources and more efficient production methods are being used to reduce environmental impact. Furthermore, the use of residual streams for animal feed and/or biogas production helps reduce waste and promote circularity within the potato processing industry. For example, dissolved starch can be recovered from water during the production process. Additionally, the use of sustainably grown palm oil contributes to reducing the environmental impact.

## Consumer

In addition to the production of potatoes and potato products, the consumer also plays a role in environmental impact. Choosing locally grown and seasonal potatoes can help reduce transport-related greenhouse gas emissions. Moreover, efficient use of water and energy during preparation is an important factor in reducing the ecological footprint. Boiling potatoes is the most sustainable method of preparation<sup>30</sup>. Reducing food waste by properly storing and preparing potatoes and potato products contributes to lowering environmental impact. According to the Netherlands Nutrition Centre's report on food waste at home in the Netherlands in 2022, potatoes (2.8 kg

wasted per person per year) are among the top five most wasted food groups, following bread and pasta (6.2 kg), vegetables (4.4 kg), fruit (4.3 kg), and equal to dairy (2.8 kg). This 2.8 kg represents 12.3% of the potatoes purchased by consumers and accounted for 8.2% of the total food waste from solid foods in the Netherlands in 2022<sup>32</sup>. The versatility of potatoes in the kitchen (e.g. in soups or sauces) offers opportunities to reduce this waste.

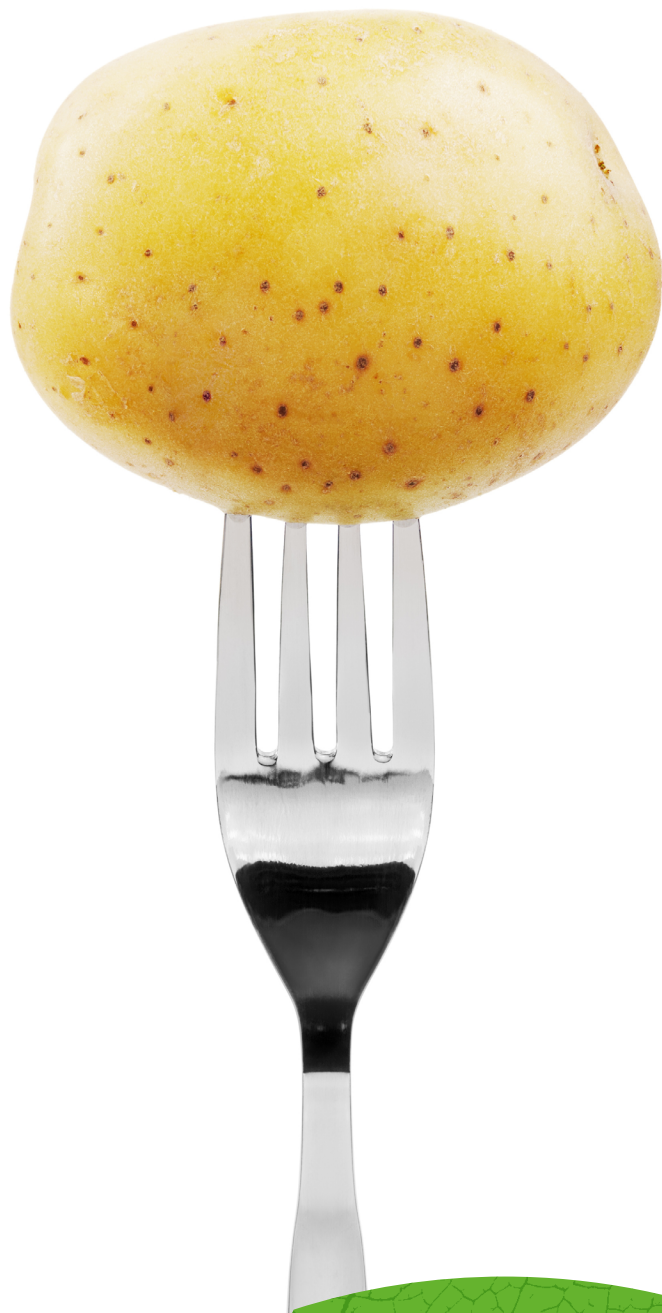
## Contribution to global food security

The potato is playing an increasingly important role in global food security for the growing world population. In addition to offering good nutritional value, it has the ability to grow in a variety of soil types and climates. This is especially important in regions of Asia, but also in Africa<sup>23</sup>. In Asia, irrigated rice cultivation is being replaced by potato cultivation due to lower water usage. In Africa, potatoes are replacing cassava due to increasing prosperity.



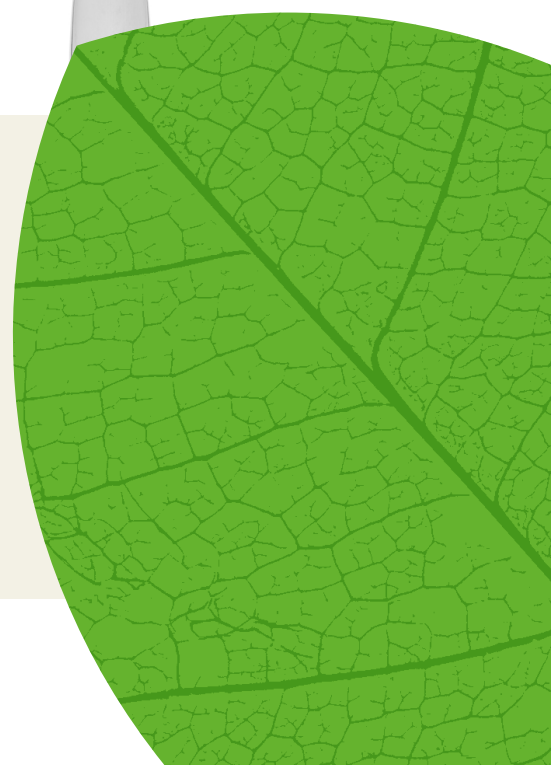
# Conclusion

From both a nutritional and environmental perspective, the potato deserves a place in a healthy and sustainable diet. Potatoes are nutritious and versatile and are considered a staple food in almost all (inter)national dietary guidelines. Furthermore, potato cultivation has a relatively low climate impact compared to other staple foods. It is expected that the potato will play an increasingly important role in global food security for the growing world population.



Cosun Nutrition Center is grateful to its Scientific Advisory Board, consisting of experts in nutrition, health and sustainability, food safety and nutrition communication, for their critical contributions to this factsheet.

Cosun Nutrition Center, December 2024



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## **Aviko and Aviko Rixona**

Aviko, part of Royal Cosun, processes potatoes into a variety of potato products, including fries, potato slices, and mashed potatoes. Aviko supplies these products to the foodservice industry, wholesalers, retail, and food manufacturing sectors worldwide with focus on quality, service, innovation and sustainability throughout the supply chain: 'from farm to fork'.

Aviko Rixona produces potato starch, flakes, and granules, which are used in food products such as sauces, soups, bakery items, and snacks. In addition, Aviko Rixona manufactures Potato Cheezz, a plant-based cheese alternative made from potatoes. Another product from Aviko Rixona, Potato TexaPure, is a plant-based ingredient made from potatoes, which can be used to enhance flavour and texture in meat substitutes and hybrid products.

Aviko's goal is to have a plant-based alternative in every category of their products by 2025. This means that in their potato specialities, animal-based products such as cheese and cream will be replaced with plant-based alternatives. With growing consumer awareness around health and sustainability, the demand for plant-based alternatives to dairy products, such as cheese and cream, is increasing. Many of these plant-based alternatives help reduce the ecological footprint of food production and consumption. This development is part of the protein transition, where plant-based alternatives contribute to a shift towards a more plant-based diet.

## **Duynie**

During the processing of potatoes into products such as fries, valuable co-products are generated. Some residual streams, such as potato peels or lower-quality potatoes, can be used in food products, for example, to make mashed potatoes. Duynie Group, part of Royal Cosun, uses residual streams from the potato processing industry to produce, among other things, animal feed and biogas. In addition, potato starch that remains in the water during processing is reused. Some of it is used in the food industry, for example as a coating for fries. Another part is processed into non-food applications such as adhesives, paper, and textiles.