

# PRACTICAL GUIDE

## PRODUCT REFORMULATION & INNOVATION FOR BETTER HEALTH



This practical guide has been developed with the utmost care, combining scientifically validated information with hands-on expertise contributed by Foodvalley's partners and external stakeholders. Every effort has been made to present the content objectively and as comprehensively as possible within the limits of available project resources and the scope this format allows.

To achieve this, the guide draws on official publications, scientific research, and the practical knowledge of field experts, including ingredient suppliers, R&D consultants, and other community partners. While grounded in science, the guide is designed to be a pragmatic tool, balancing technical insight with real-world applicability.

The case studies and listed producers or suppliers have been included based on contributions from our community network. They are intended to inspire and showcase available solutions and applications, rather than to serve as an exhaustive or independently verified overview. Foodvalley has made every effort to ensure the accuracy and relevance of the content but does not guarantee completeness or endorse specific products or suppliers. This guide is intended as a living document and may be updated as new insights, ingredients, and stakeholders emerge.

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# REDESIGN FOOD FOR VALUE

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European Union

# Introduction

This is a practical guide to reformulation and innovation for improving food products' nutritional value. It stems from Foodvalley's Healthier Food Community and its partners, which saw an opportunity to share pre-competitive knowledge to support R&D teams in making reformulation more efficient and successful. The guide includes information on ingredient functions and key considerations when adapting processed foods. Key areas include salt, sugar, saturated fat, and fibres, following the Dutch National Approach to Product Improvement (NAPV).

Beyond R&D, this resource helps commercial teams understand the opportunities, challenges, and trade-offs of reformulation, fostering collaboration between technical experts and business professionals.

Reformulation isn't as simple as swapping ingredients; taste, texture, mouthfeel, and appearance are deeply connected. Even small changes can impact consumer perception. Success, therefore, requires a tailored approach, balancing health improvements with functionality and appeal. Rather than offering a one-size-fits-all blueprint, this guide provides direction and inspiration to help food professionals make informed decisions that align with both health objectives and product integrity.

Whether you're a food technologist, sales professional, or manager, this guide can support you in expanding your understanding of reformulation, innovation and available solutions. Use it as a reference, explore key topics, or dive deeper into additional resources. Share it with colleagues to spark new insights and ideas.

Will you let us know if it has been beneficial to you and if you have any suggestions to optimise the value of the guide?

*The Healthier Food Community - Foodvalley*

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# Reading Guide

This practical guide is designed to be interactive and easy to navigate, catering to both experts and non-experts interested in product reformulation and innovation.

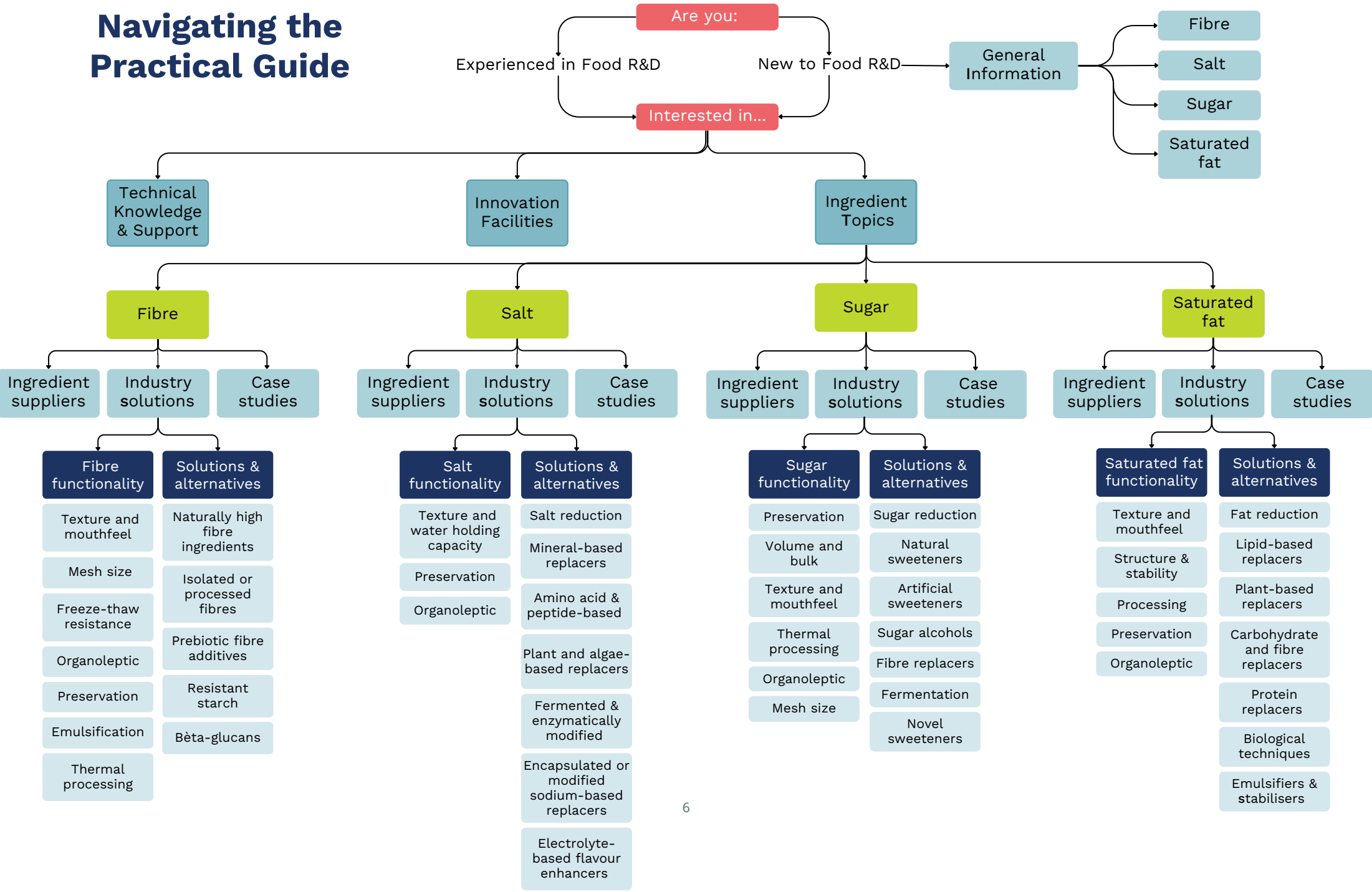
For each macronutrient, general information, food industry solutions, relevant ingredient suppliers, and case studies are presented. The **General Information** contains information on the various aspects of the macronutrient: definition, health aspects, recommended intakes, relations to Nutri-Score and NAPV, and suggestions for further readings. **Food Industry Solutions** describes functionality aspects and solutions available in the market. **Ingredient Suppliers** gives an overview of ingredient suppliers that can supply the necessary ingredients, and in **Case Studies**, you will read about challenges met and solutions found by companies working on reformulating products. The guide concludes with the technical knowledge and support available in the market that can support reformulation and innovation processes in general.

To help you find the most relevant information quickly, we have included a clickable decision tree on the next page that guides you based on your interests and needs. Throughout the document, you can always navigate back to this decision tree by clicking on 'GO BACK TO DECISION TREE' in the bottom right corner.

- **Start with the decision tree:** If you're unsure where to begin, use the clickable decision tree to find the section that best matches your goal. Whether you're looking for technical insights, case studies, or ingredient suppliers, the tree directs you to the right place.
- **Follow the links:** Throughout the report, you'll find clickable links that take you directly to related sections or other relevant information.
- **Choose your depth:** Each nutrient section is structured to provide both high-level overviews and quick insights, as well as more in-depth analysis for those seeking detailed expertise.
- **Visual and interactive aids:** Key takeaways are highlighted for easy reference. Look out for tables, infographics, and case studies that bring complex topics to life and provide practical examples.

Whether you're an experienced professional or new to product reformulation, this report is designed to help you explore at your own pace and find exactly what you need.

# Navigating the Practical Guide





# Fibre

01

## General Information

- Background
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# 01 General Information Fibre

## Background

**Dietary fibre** is defined by EU Regulation 1169/2011 as: “carbohydrate polymers with three or more monomeric units, which are neither digested nor absorbed in the human small intestine” (European Parliament and Council of the European Union, 2011).

**Functional fibre** refers to isolated, extracted, or synthetically manufactured nondigestible carbohydrates (Turner & Lupton, 2011). This classification contrasts with dietary fibre, which is naturally occurring. Functional fibres and dietary fibres together represent the total fibre content of the food (Turner & Lupton, 2011).

On average, **intakes** for adult males in Europe range from 18-24 g per day and for females 16-20 g per day (EUFIC, 2023), with little variation from one European country to another (Figure 1). In the Netherlands intake of fibre is 21 g/day on average, with a higher intake among boys/men (23 g/day) than among girls/women (18 g/day) (RIVM, 2023).

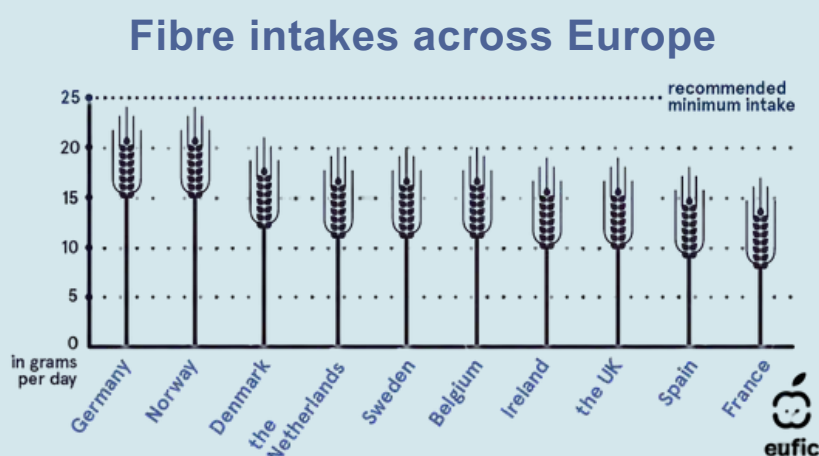


Figure 1: Fibre intakes per inhabitant across European countries in g/day (EUFIC, 2023).

In the EU, whole grain cereals, pulses, fruit, vegetables and potatoes are the most commonly consumed **sources** of dietary fibre (European Commission, 2023a). The different types of dietary fibre, examples and main sources of intake are explained in Table 1. Groups and fibre classifications are not mutually exclusive, and some fibres can be classified in two or more categories (Voedingscentrum, n.d.-a).

Table 1: Types of dietary fibre, their solubility, health effects, and examples of sources (He et al., 2022; Carlson et al., 2018).

Type of fibre	Solubility	Health effect	Examples	Sources
<b>Soluble fibre</b>	Soluble	Beneficial to cholesterol levels and regulation of blood sugars	Pectin, beta-glucan	Oats, beans, apples, citrus fruits
<b>Insoluble fibre</b>	Insoluble	Adds bulk to the stool, promoting regular bowel movements and preventing constipation	Lignin, hemicellulose	Whole grains, nuts, seeds, vegetables
<b>Fermentable fibre</b>	Both soluble and insoluble	Fermented in the colon, producing beneficial short-chain fatty acids	Inulin, fructooligosaccharides	Legumes, whole grains, onions, bananas
<b>Prebiotic fibre</b> (subset of fermentable fibres)	Both soluble and insoluble	Serves specifically as a food source for beneficial bacteria in the colon	Galactooligosaccharides, resistant starches	Chicory root, asparagus, leeks, bananas

# Health Aspects



## DIGESTION

Fibre plays a crucial role in maintaining digestive health by promoting regular bowel movements and preventing constipation (Barber et al., 2020). Soluble fibre absorbs water, softening stool, while insoluble fibre adds bulk, helping food pass more easily through the digestive tract (Guan et al., 2021; Voedingscentrum, n.d.-a).

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## SATIATION

Fibre increases feelings of fullness or satiety by absorbing water and expanding in the stomach, which slows down the digestion process (Hervik & Svihus, 2019). This delay in gastric emptying helps reduce overall calorie intake by decreasing hunger and promoting portion control (Hervik & Svihus, 2019; Nirmala Prasadi & Joye, 2020). Soluble fibre, in particular, is known to help control appetite and prevent overeating (Guan et al., 2021).

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## REDUCED RISK CARDIOVASCULAR DISEASES

High fibre intake is associated with a reduced risk of cardiovascular disease. Fibre helps lower cholesterol levels by binding to bile acids in the intestines, preventing their reabsorption (Guan et al., 2021). This can reduce plaque buildup in the arteries, ultimately lowering the risk of cardiovascular events (Barber et al., 2020).

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## REDUCED RISK OF TYPE 2 DIABETES

Increased fibre intake is linked to better blood sugar control and reduced risk of type 2 diabetes (Guan et al., 2021). Soluble fibre in particular helps to slow the absorption of sugar, preventing spikes in blood glucose. Additionally, fibre improves insulin sensitivity, thereby aiding in preventing diabetes (Guan et al., 2021).

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## REDUCED RISK OF COLON CANCER

Fibre has been shown to lower the risk of colon cancer (Barber et al., 2020). It is thought to work by increasing stool bulk and decreasing transit time, reducing the exposure of the colon to harmful substances (Nirmala Prasadi & Joye, 2020). Additionally, fibre's fermentation in the colon may protect against cancerous cell development (Guan et al., 2021).

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# Regulatory Framework

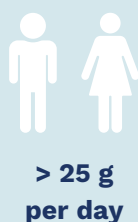
## Dietary Recommendations

The World Health Organisation (**WHO**) recommends consuming 25 g of naturally occurring dietary fibre per day (World Health Organization, 2023a). Likewise, the European Food and Safety Authority (**EFSA**) considers an intake of 25 g of fibre per day to be adequate for normal bowel function in adults (EFSA, 2010).

**Dutch recommendations** for dietary fibre intake differentiate between men and women. Adult women are advised to consume at least 25 g per day and adult men at least 30 g per day.

In addition, evidence shows that adults gain increased health benefits with intakes of dietary fibre above the recommended amounts (Voedingscentrum, n.d.-a). It is important to note that the role of fibre on its own is not always clear, therefore it is important to eat whole foods rich in fibre, not only isolated fibre.

### WHO and EFSA recommendations dietary fibre intake per day



### Dutch recommendations dietary fibre intake per day



## Health Claims

Allowed health claims in EU:

- **Source of fibre:** amount of fibre in the product  $\geq 3$  g/100 g product or 1.5 g/100 kcal.
- **Rich in fibre:** amount of fibre in the product is  $\geq 6$  g/100 g product or 3 g/100 kcal (Voedingscentrum, n.d.-a; European Commission, 2012).

In the Netherlands, the Dutch Food and Consumer Product Safety Authority (NVWA) states that the term '**wholemeal**' or '**wholegrain**' may and must be used in the name of the product only if 100% wholegrain flour is used, including cookies, crackers, pasta, or bread (Nederlandse Voedsel- en Warenautoriteit, 2024a).

# Nutri-Score

Nutri-Score assigns positive points to dietary fibres in food products, up to a maximum of 5 points (RIVM, 2024).

In the Netherlands, Rijksinstituut voor Volksgezondheid en Milieu (RIVM) has provided a [calculation tool](#) for the Nutri-Score of a product.

## NAPV

NAPV limit values for fibre are developed solely for the 'Bread (replacements) and breakfast cereals' category because the fibre content can be adjusted by increasing the ratio of wholemeal flour relative to refined flour (RIVM, 2022).

In other product categories there is still a lot of potential to increase fibre content. However, setting an NAPV limit value within these food groups will mainly focus on adding processed fibre (possibly in combination with adjusting the ratio of flour and/or wholemeal flour). For this reason, no limits are set for fibre content, despite a contribution of some groups of more than 3% to total fibre intake (RIVM, 2022).

Despite there being no specific targets on fibre increase in the NAPV, there still is a lot of potential to positively impact health by increasing the amount of fibres in processed foods, when using the right type of fibres or fibre rich ingredients.

NAPV developed limit values for fibre in the following product categories:

- |   |   |
|---|---|
| <input checked="" type="checkbox"/> Bread(replacements) and breakfast cereals | <input type="checkbox"/> Spreads and cooking fats |
| <input type="checkbox"/> Dairy and plant-based alternatives                   | <input type="checkbox"/> Soups and bouillons      |
| <input type="checkbox"/> Cheese   | <input type="checkbox"/> Sauces                   |
| <input type="checkbox"/> Meat preparations and meat products                  | <input type="checkbox"/> Savoury snacks           |
| <input type="checkbox"/> Deli meats and preserved meats                       | <input type="checkbox"/> Pastry & confectionary   |
| <input type="checkbox"/> Fish   | <input type="checkbox"/> Drinks                   |
| <input type="checkbox"/> Meat substitutes                                     | <input type="checkbox"/> Sandwich filling         |

Learn more: [NAPV roadmap](#)

# Further Readings



## **Action on Fibre Initiative - Food & Drink Federation (2023)**

An industry-led effort by the Food & Drink Federation to bridge the gap between current fibre intakes and dietary recommendations. They include details on the initiative's impact, including increased availability of high-fibre products.

## **Carbohydrate intake for adults and children: WHO guideline**

This guideline provides updated, evidence-informed guidance on the intake of carbohydrates to reduce the risk of diet-noncommunicable diseases in adults and children, with a particular focus on carbohydrate "quality".

## **Dietary fibre - Institute of Food Science & Technology (2023)**

Food Reformulation for dietary fibre by the Institute of Food Science & Technology (IFST) examines a multitude of aspects related to dietary fibre intake and using it in product formulation. It highlights key functional properties including how to analyse for dietary fibre.

## **Dutch National Food Consumption Survey (2019-2021)**

This survey provides comprehensive data on the dietary habits of the Dutch population aged 1 to 79 years. It offers insights into nutrient intake, including dietary fibre, and informs public health policies and nutritional guidelines in the Netherlands.

## **EUR-Lex Regulation (EC) No 1924/2006 on Nutrition and Health Claims**

This legislation provides the legal framework for nutrition and health claims made on foods within the EU. It specifies the conditions under which claims like "fibre-rich" can be made, ensuring that consumers receive truthful and substantiated information.

## **Guidance for product innovation and reformulation (2023)**

Comprehensively outlines the aspects of product innovation and reformulation that may need to be considered when undertaking reformulation work.

# 02 Food Industry Solutions Fibre

## Fibre Functionality

### **Texture and mouthfeel**

Fibres, especially soluble and functional insoluble, can absorb and retain water (water binding capacity) and oil, forming a gel-like matrix that enhances creaminess or viscosity (Goff & Guo, 2019; Dhingra et al., 2012). This property helps mimic fat's mouthfeel in low-fat dairy, sauces, and dressings. However, fibres can also impact mouthfeel in a different way. Insoluble fibres may contribute to grittiness, while higher concentrations can introduce unwanted off-tones, such as bitterness and earthiness.

### **Freeze-thaw resistance**

Fibres, particularly those from plant-based sources, can absorb water and undergo structural changes when frozen and thawed. This can lead to (undesirable) alterations in texture, consistency, and overall product quality. Ensuring that fibres maintain their functional properties during freeze-thaw cycles requires careful formulation and processing (Dhingra et al., 2012).

### **Mesh size**

Mesh size influences the texture, solubility, and functionality of the fibre in the final product (Dhingra et al., 2012). Depending on the type of fibre, large particles may not integrate well, leading to an undesirable texture or poor dispersibility, while excessively fine fibres can cause clumping. Optimising mesh size ensures consistency, mouthfeel, and stability (Mancebo et al., 2018).

### **Organoleptic**

The colour and appearance of a product may be affected, depending on the fibre's pH sensitivity, source, and concentration (Dhingra et al., 2012). In baked goods, dietary fibres can potentially cause dryness and weakening of gluten networks, which impacts rise, texture, and crumb structure (Gómez & Martinez, 2018).

### Caloric reduction and emulsification

Fibres can replace part of the fat and sugar in formulations without significantly altering the product volume (Dhingra et al., 2012). Some have emulsifying properties that stabilise oil-in-water emulsions, reducing the need for added fats while maintaining creamy textures (Dhingra et al., 2012). Certain fibres also enhance thickening when combined with hydrocolloids like carrageenan or gelatin (Dhingra et al., 2012; Marczak & Mendes, 2024).

### Thermal processing

In general, thermal processing leads to the loss of nutritional and bioactive molecules, reduces soluble compounds in fibre, and impacts colour, hydration properties, and cell integrity (Fernández-López et al., 2020).

### Preservation and moisture retention

Fibres are naturally hydrophilic. This property allows fibres to hold water within the product matrix, reducing water activity and slowing down staling or drying out by preventing moisture migration and maintaining product freshness (Marczak & Mendes, 2024). However, improper processing can lead to unstable products and reduced shelf life if excess water isn't properly captured (Perez-Pirotto, 2022).

Table 2: Overview fibre functionalities and sensory attributes.

Process/product functionality	Sensory attributes
<b>Freeze-thaw resistance</b> , fibres can absorb water and undergo structural changes when frozen and thawed.	<b>Creaminess and viscosity</b> , fibres can create a gel-like structure ideal for creamy products.
<b>Bulk replacer</b> , fibres can replace part of the fat or sugar in formulations without significantly altering the product volume.	<b>Organoleptic properties</b> should be carefully considered in product formulation to obtain the desired qualities.
<b>Preservation</b> , fibres help slow down staling and maintain product freshness.	<b>Mesh size</b> , influences texture, solubility, and functionality of the fibre.
Certain fibres have <b>emulsifying properties</b> and can improve thickening and <b>stability</b> .	<b>Thermal processing</b> can affect colour and hydration properties of some type of fibres.

# Fibre Solutions

## Naturally high fibre ingredients, fresh or dried produce, bran

The following tables provide an overview of potential ingredient solutions for reformulation, distinguishing between nutritional and functional aspects. This distinction reflects the different objectives that may drive reformulation or innovation, such as improving the nutritional profile (e.g., reducing sugar, salt, or saturated fat) versus maintaining or enhancing product functionality (e.g., texture, stability, or shelf life). The tables are intended as a starting point for identifying possible solutions. They do not represent an exhaustive list, and additional considerations may apply depending on the specific product context and formulation goals.

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
<b>Whole Grains (Oats, Barley, Quinoa, Brown Rice)</b>	Bread (replacements) and cereals	Enhances texture and structure in baked goods (Ma et al., 2022a).	Can make products denser and drier; May require additional moisture or binding agents (Bressiani et al., 2017).	Rich in fibre, B vitamins, and minerals (Pujol et al., 2023).	Wholegrains may increase acrylamide levels (Boyaci Gunduz, 2023).
<b>Bran (Wheat Bran, Oat Bran, Rice Bran)</b>	Bread (replacements) and cereals	Increases fibre content in baked goods (Tyl et al. 2021).	Can make products crumbly or dry; Requires moisture adjustments (Tyl et al. 2021).	High in insoluble fibre; Supports bowel regularity (de Vries, 2015).	Can cause digestive discomfort when consumed in large amounts (Miller et al., 2015).

## Naturally high fibre ingredients, fresh or dried produce, bran (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Green Banana (flour)</b>	Bakery products, pasta, snacks, gluten-free products	Improves texture and viscosity; Acts as a thickening/ stabilising agent; Extends shelf life (Fida et al. 2020; Sumble & Salve, 2024).	May alter taste and colour profile; Requires formulation adjustment to achieve desired texture (Fida et al. 2020).	High in resistant starch (prebiotic effect); Low glycemic index; Source of potassium and fibre (Fida et al. 2020; Sumble & Salve, 2024).	Nutrient content may vary with processing; Can be less palatable due to astringency if not balanced (Fida et al. 2020).
<b>Fruits</b>	Bars and bakery products	Adds natural sweetness and moisture (Krajewska & Dziki, 2023).	Can increase water binding capacity, affecting shelf life and requiring preservation adjustments (Krajewska & Dziki, 2023).	High in soluble fibre (pectin), antioxidants, and vitamins (Fierascu et al. 2020; Krajewska et al. 2023).	Increased processing degrades nutritional quality of fruits by reducing alkalizing, antioxidant, and satiety effects (Fardet & Richonnet 2020).
<b>Vegetables</b>	Meat alternatives, savoury snacks	Adds bulk and texture, especially in savoury dishes (Pop et al. 2021).	May alter flavour profile and require balancing spices; Fibre can become tough when overcooked (Oyinloye & Yoon, 2020).	Provides vitamins, minerals, and both soluble and insoluble fibre (Pop et al. 2021).	Some fibres may interact with some nutrients and inhibit their absorption into the digestive system (Pop et al. 2021).

# Isolated or Processed Fibre Ingredients

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
<b>Psyllium Husk (Plantago Ovata)</b>	Bakery products, bread (replacements) and cereals	Excellent water retention and gelling properties; Good for gluten-free baking (Fradinho et al., 2020).	Can create overly gummy textures if not balanced correctly (Belorio & Gómez, 2021).	Supports heart health by lowering cholesterol (Geremew et al., 2024).	Requires adequate water intake to prevent digestive issues (Geremew Kassa et al., 2024).
<b>Pectin</b>	Dairy alternatives, sauces	Improves stability in beverages and acidic products and mimics mouthfeel of fat (Freitas et al., 2021).	Works best in acidic environments (pH < 3.5 for high-methoxyl pectin) (Freitas et al., 2021).	Supports digestion and gut health (Beukema et al., 2020).	While minimal, some pectin-rich products (like jams) may still be high in sugar (Blanco-Pérez et al., 2021).
<b>Cellulose</b>	Bakery products	Improves structure in low-carb or high-fibre bakery products (Ahmad Khorairi et al., 2023).	May result in a dry mouthfeel if used in excess.	Adds bulk without affecting glycemic response (Giuntini et al., 2022).	May interfere with mineral absorption at high levels (Baye et al., 2017).
<b>Guar Gum (Guar Beans)</b>	Sauces, dressings, dairy products	Thickens and stabilises foods like sauces and dressings (Jayanthi et al., 2024).	Can lead to slimy textures if overused; Sensitive to temperature changes (Jayanthi et al., 2024).	Soluble fibre helps in blood sugar control (Cassidy et al., 2018).	Can cause digestive discomfort when consumed in large amounts (Major et al., 2017).

# Prebiotic Fibre Additives

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Fructooligo-saccharides (FOS)</b>	Snacks, dairy alternatives	Adds mild sweetness without increasing calories (Bali et al., 2015).	High concentrations may cause moisture retention, affecting texture (Kherade et al., 2021; Zeng et al., 2016).	Stimulates growth of beneficial gut bacteria (Bali et al., 2015).	Can cause gas or bloating when consumed in large amounts (Miller et al., 2015).
<b>Galactooligo-saccharides (GOS)</b>	Dairy products	Minimal impact on taste and texture; Easily incorporated into dairy (Olivares-Tenorio et al., 2022).	Limited stability under high temperatures; may break down during cooking (Abdaltef et al., 2024).	Enhances calcium absorption and immune function (Abdaltef et al., 2024).	Not all individuals tolerate GOS well (FODMAP-sensitive people) (Varney et al., 2017).
<b>Inulin (Chicory Root Extract)</b>	Baked goods and dairy products	Adds creaminess and improves mouthfeel in low-fat products (Ahmed & Rashid, 2019).	pH-sensitive: Acidic environments (e.g., fruit juices) may lead to hydrolysis, reducing its functionality (Ahmed & Rashid, 2019).	Prebiotic effect supports gut microbiota (Qin et al., 2023).	Can cause gas or bloating when consumed in large amounts (Miller et al., 2015).

# Resistant Starch (RS)

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
<b>RS1 (Occurs in whole grains, seeds)</b>	Bread (replacements) and cereals	Adds bulk and enhances structure in baked goods (Mishra & Awasthi, 2024).	May require adjustments in cooking times or hydration for texture optimisation (Homayouni et al., 2014; Kraithong et al., 2022).	Improves blood sugar control and supports satiety (Kraithong et al., 2022).	Can cause gas or bloating when consumed in large amounts (Miller et al., 2015).
<b>RS2 (Occurs in, raw potatoes, green bananas)</b>	Bars and snack products	Substrate for the synthesis of short-chain fatty acids (Sumble & Salve, 2024).	Loses resistant properties when cooked, requiring careful handling (Lui et al., 2020).	Acts as a prebiotic and improves gut health (Sumble & Salve, 2024).	Can cause gas or bloating when consumed in large amounts (Walsh et al., 2022).
<b>RS3 (Occurs in cooled cooked rice, pasta, potatoes)</b>	Processed snacks	Adds structure to products after cooling; Enhances firmness in pasta and baked goods (Ashwar et al., 2016).	Requires cooling processes, which may complicate production (Ashwar et al., 2016).	Supports colon health and reduces post-meal glucose spikes (DeMartino & Cockburn, 2020).	Reheating may reduce the resistant starch content (Gu et al., 2020).

## Resistant Starch (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>RS4 (Chemically Modified Starches)</b>	Sauces, snacks, bakery products	Stable under various processing conditions; Good for industrial applications (Walsh et al., 2022).	May alter product labeling requirements due to chemical modifications (Walsh et al., 2022).	Provides similar health benefits to natural resistant starches (Upadhyaya et al., 2016).	Due to processing, may not be perceived as “natural” by consumers.

Classification based on EFSA report

# Bèta-Glucans

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Oat Beta-Glucans</b>	Bakery products, soups	Retains moisture and enhances viscosity in soups, beverages, and baked goods (Li et al., 2024).	Can lead to overly thick or gummy textures in high concentrations (Lante et al., 2023).	Helps lower LDL cholesterol and regulate blood sugar levels (Li et al., 2024).	Requires consistent consumption for heart health benefits (Lante et al., 2023).
<b>Yeast Beta-Glucans</b>	Meat alternatives	Acts as a stabilizer and emulsifier in processed foods (Zechner-Krpan et al., 2009).	May impart a slight yeast-like taste at high concentrations.	Enhances immune response and supports gut health (Sinangil et al., 2022).	Can cause digestive discomfort when consumed in large amounts (Miller et al., 2015).
<b>Mushroom Beta-Glucans (Reishi, Shiitake, Maitake)</b>	Meat alternatives	Used in supplements and functional beverages for health benefits (Chiozzi et al., 2021).	Earthy flavor may need masking in certain products (Zhao et al., 2022).	Supports immune function and offers antioxidant protection (Sinangil et al., 2022).	Possible allergic reactions in sensitive individuals (Singh et al., 2024a).

# 03 Ingredient Suppliers Fibre

## Functional Ingredient Suppliers

An extensive (not exhaustive) overview of ingredients and ingredient suppliers is available in the linked **Google Sheets database**.

Connect with ingredient suppliers within the Healthier Food Community:

dsm-firmenich ●●●



saledo



1·2taste\*

\*Ingredient marketplace for food manufacturers

Are you missing any information, suppliers or ingredients?  
Please contact **healthierfood@foodvalley.nl** and we can  
incorporate this in our next version.

# 04 Case Studies

## Fibre



# Calorie reduced ice-cream



## What challenge was faced?

The challenge was to create a calorie-reduced ice cream by significantly lowering fat and sugar content, while preserving the indulgent taste and creamy mouthfeel.

## How was the problem solved?

The key was finding the right texture by increasing water content (+8%) and cutting back sugar by 65%. A smart combination of functional citrus fibre and pectin delivered a full-bodied mouthfeel, while also supporting overrun and emulsification. This approach allowed the formulation to retain the sensory qualities of traditional ice cream despite the nutritional overhaul.

## Were there any obstacles?

Reducing fat posed a challenge, as fat is central to the ice cream's body and texture. This was addressed by incorporating functional citrus fibre. Sugar was replaced with sugar alcohols, which altered the freezing point and affected recrystallisation. The loss of structure was compensated with pectin, functional fibre, and soluble fibre to maintain creaminess and reduce ice crystal formation.

## What was the outcome?

Fat was reduced by 82%, sugar by 41%, and calories by 53%, improving the product from Nutri-Score D to A. The final product featured a smoother texture and lower melting behaviour.

## Key takeaways and lessons learned

A well-balanced blend of fibre and pectin can successfully replace fat and sugar while preserving indulgence. This combination is essential for achieving a creamy texture and a full-bodied mouthfeel in calorie-reduced ice cream.

## For more details, contact:



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“A well-balanced blend of fibre and pectin can successfully replace fat and sugar while preserving indulgence.”

# Healthy raw bar - Less fat, sugar and more fibre and resistant starch with green banana flour



saledo

## What challenge was faced?

Most snack bars are high in sugar, additives, and fats. Consumers seek natural, functional foods for gut health and sustained energy, but food producers struggle to reduce sugar and fat while maintaining taste and texture.

## How was the problem solved?

Saledo is developing a raw bar with Green Banana Flour (GBF), rich in resistant starch, potassium, magnesium, and fibre. GBF has water and oil holding capacities, which allows for reduced sugar and fat while ensuring a satisfying texture and supporting gut health.



	Original Recipe	Saledo Recipe 2	Saledo Recipe 1
<b>Recipe 1</b>	Original	Saledo	Change
Fibre	3,1	3,45	10,14%
Sugar	13,65	10,44	-30,73%
Fat	9,65	7,2	-34,03%
<b>Recipe 2</b>	Original	Saledo	Change
Fibre	3,1	3,15	1,59%
Sugar	13,65	10,70	-27,62%
Fat	9,65	9,575	-0,78%

## Were there any obstacles?

Saledo addressed ingredient compatibility to ensure appealing texture, tackled consumer acceptance through education and tastings, and worked with Foodvalley to scale production while safeguarding product quality.

## What was the outcome?

Two recipes were created: one with 30.73% less sugar, 34% less fat, and 10.14% more fibre, yielding a firmer, less sweet option; another with 27.62% less sugar, 0.78% less fat and slightly more fibre (1.59%), maintaining familiar taste and texture while reducing sugar.

## Key takeaways and lessons learned

This case study reinforces how green banana flour serves as a high-fibre, lower-sugar, and gut-friendly alternative to traditional flours with its no taste oil and water-holding capacities. The key takeaway is its potential in healthier food formulations, making it ideal for better digestion, lower fat intake, and balanced blood sugar levels.

## For more details, contact:



[Duygu@saledo.com.tr](mailto:Duygu@saledo.com.tr)

[Alican@saledo.com.tr](mailto:Alican@saledo.com.tr)

# Enrichment of beverages with soluble fibre

1·2taste

## What challenge was faced?

Consumers increasingly seek convenient products that support gut health and immunity. The goal was to develop a beverage containing enough fibre to deliver a measurable prebiotic effect—without compromising on taste, texture, or drinkability.

## How was the problem solved?

A flavourful beverage was formulated using a carefully selected blend of plant-based fibres. The fibre mix was optimised to ensure that a small, effective dose delivered proven gut health benefits, while still offering a smooth drinking experience.

## Were there any obstacles?

One limitation remains the operating regulatory framework. While clinical trials in the US support strong health claims, current EU regulations restrict claims to softer language. This influences how the product's benefits can be communicated in the European market.

## What was the outcome?

The beverage delivers gut health support in a low-dose format, maintaining both taste and functional value. The fibre Benicaros, in particular, showed excellent stability in low pH conditions, making it ideal for acidic drinks.

## Key takeaways and lessons learned

Benicaros proves to be a highly effective and stable fibre for functional drinks, requiring just 850 mg per serving to have an impact. Additionally, ingredients like Allsweet Allulose offer promising solutions in other applications such as baked goods—providing sugar-like bulk with only 10% of the calories. While Allulose awaits EU novel food approval, it is already permitted in other markets and is expected to be authorised in Europe soon.

## For more details, contact:



Walter Blom

[walter.blom@12taste.com](mailto:walter.blom@12taste.com)

“

Benicaros proves to be a highly effective and stable fibre for functional drinks, requiring just 850 mg per serving to have an impact.”



# Salt

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- Health Aspects
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# 01 General Information Salt

## Background

Salt is a chemical compound made up of sodium and chloride (NaCl). It consists of 40% sodium and 60% chloride by weight (Voedingscentrum, n.d.-b). Salt is the most important source of sodium in human diets, however, when consumed in large amounts, sodium is detrimental to health. Nevertheless, small amounts of sodium are essential for the human body and necessary for the maintenance of plasma volume, acid-base balance, transmission of nerve impulses and normal cell function (WHO, 2023). Salt is defined by EU Regulation 1169/2011 as 'the salt equivalent content calculated using the formula: salt = sodium  $\times$  2,5' (European Parliament and Council of the European Union, 2011). In this report, "salt" refers to NaCl unless stated otherwise.

The **global mean intake** of salt in adults is 10.78 g/day. This is more than double the World Health Organization recommendation for adults (equivalent to < 5 g/day salt). Across the sodium reduction reformulation policies implemented in the 194 WHO Member States, bread and bread products are the primary focus. They are followed by processed meats, poultry, game, and fish, as well as ready-made and convenience foods (World Health Organization, 2023b).

The average salt **intake in the Netherlands** is 6.6 g/day, with a maximum recommended intake of 6 g per day. One gram of this salt intake originates from added salt during preparation and at the table, whereas 5.6 g originates from purchased food products. Intake is higher for boys/men (7.4 g/day) than for girls/women (5.9 g/day). The main **sources** of salt intake (excluding table salt) are bread, cereals, rice and pasta (25%), meat and meat substitutes (20%), dairy and dairy substitutes (17%) and sauces and flavourings (10%) (RIVM, n.d.).

# Health Aspects



## INCREASED BLOOD PRESSURE (HYPERTENSION)

Excess salt causes the body to retain water, increasing blood volume and raising blood pressure. Over time, this puts strain on the heart and blood vessels, increasing the risk of heart disease and stroke. Reducing salt intake can help lower blood pressure and improve heart health (Mozaffarian et al., 2014).

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## INCREASED RISK OF OBESITY

Excessive salt consumption is associated with higher calorie intake and obesity, as it enhances appetite and promotes over-consumption of processed foods. High salt intake may also alter fat metabolism and contribute to insulin resistance (Moosavian et al., 2017).

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## INCREASED RISK OF GASTRIC CANCER

High salt intake can damage the stomach lining, leading to inflammation and an increased risk of *Helicobacter pylori* infection, a major cause of gastric cancer (D'Elia et al., 2014).

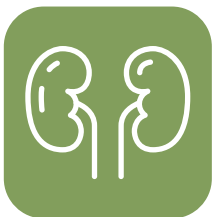
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## INCREASED RISK OF OSTEOPOROSIS

Excessive salt intake promotes calcium excretion in urine, leading to decreased bone mineral density and an increased risk of osteoporosis. High sodium intake is linked to lower bone mass, especially in postmenopausal women (Cappuccio et al., 2000).

---



## INCREASED RISK OF KIDNEY DISEASE

High sodium intake strains the kidneys by increasing blood pressure and promoting kidney damage. It accelerates the progression of chronic kidney disease and increases proteinuria, a marker of kidney dysfunction (Borrelli et al., 2020).

---

# Regulatory Framework

## Dietary Recommendations

The **WHO** and **EFSA** recommend less than 2 g/day of sodium (equivalent to less than 5 g/day salt), or just under a teaspoon (World Health Organization, 2012; Turck et al., 2019). This level is considered by EFSA as a “safe and adequate intake for the general EU population of adults,” including pregnant and lactating women.

The **Dutch Health Council** advises adults to consume no more than 6 g of salt a day, equivalent to 2.4 g of sodium (Gezondheidsraad, 2015).

### WHO and EFSA recommendation sodium intake per day



**< 2 g  
per day**

### Dutch recommendation sodium intake per day



**≤ 2.4 g  
per day**

## Health Claims

Allowed health claims in EU:

- **Low sodium/salt:** The product contains a maximum of 0.12 g of sodium, or the converted amount of salt, per 100 g or 100 ml. This does not apply to water.
- **Very low sodium/salt content:** The product contains a maximum of 0.04 g of sodium, or the converted amount of salt, per 100 g or 100 ml.
- **Sodium-free/saltless:** The product contains a maximum of 0.005 g of sodium, which is 0.0125 g of salt per 100 g.
- **No added sodium/salt:** No sodium/salt has been added to the product. The product contains a maximum of 0.12 g of sodium, or the converted amount of salt, per 100 g or 100 ml (European Commission, 2006).

## Nutri-Score

The lower salt limit used by Nutri-Score is  $\leq 90$  mg sodium per 100 g of product. Nutri-Score assigns negative points for salt based on the quantity present in 100 g or 100 ml of the product, up to 10 negative points can be given (RIVM, 2024).

In the Netherlands, RIVM has provided a [calculation tool](#) for the Nutri-Score of a product.

## NAPV

For salt, the NAPV established limit values for multiple product categories, with specific subcategories defined for each. When possible, the lower limits of the NAPV correspond to the lowest cut-off points that Nutri-Score uses. Consult the [source document](#) for detailed values applicable to individual products (RIVM, 2022).

NAPV developed limit values for salt in the following product categories:

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Bread(replacements) and breakfast cereals | <input checked="" type="checkbox"/> Spreads and cooking fats |
| <input type="checkbox"/> Dairy and plant-based alternatives                   | <input checked="" type="checkbox"/> Soups and bouillons      |
| <input checked="" type="checkbox"/> Cheese                                    | <input checked="" type="checkbox"/> Sauces                   |
| <input checked="" type="checkbox"/> Meat preparations and meat products       | <input checked="" type="checkbox"/> Savoury snacks           |
| <input checked="" type="checkbox"/> Deli meats and preserved meats            | <input type="checkbox"/> Pastry & confectionary              |
| <input checked="" type="checkbox"/> Fish                                      | <input type="checkbox"/> Drinks                              |
| <input checked="" type="checkbox"/> Meat substitutes                          | <input checked="" type="checkbox"/> Sandwich filling         |

Learn more: [NAPV roadmap](#)

# Further Readings



## **EUR-Lex Regulation (EC) No 1924/2006 on Nutrition and Health Claims**

This legislation provides the legal framework for nutrition and health claims made on foods within the EU. It specifies the conditions under which claims like "reduced salt" can be made, ensuring that consumers receive truthful and substantiated information.

## **FoodDrinkEurope Guidelines: Reducing Salt in Food Products**

Provides practical information for food business operators on reducing sodium content in food and beverages. It covers strategies for gradual salt reduction, alternative seasoning options, and maintaining product quality and safety during reformulation.

## **Reformulation of food and beverage products for healthier diets: WHO policy brief**

Provides information and practical guidance for implementing effective policy actions to eliminate industrially produced trans-fatty acids from the food supply, reduce the energy content per portion and lower the levels of saturated fats, sugars and salt/sodium in food.

## **Technical Brief: Food Reformulation for Salt**

Examines the health implications of high sodium intake and emphasizes the importance of product reformulation to reduce sodium levels in processed foods and discusses strategies for achieving this goal.

## **The use of salt substitutes to replace sodium chloride in food products: a review**

This report examines salt substitutes in staple foods, highlighting innovations like low-sodium blends, flavour enhancers, and advanced techniques to reduce salt while preserving quality.

## **Use of lower-sodium salt substitutes: WHO guideline**

Evidence-based recommendations for using lower-sodium salt substitutes to help reduce sodium intake, lower hypertension risk, and prevent noncommunicable diseases. It supports policymakers, health professionals, and stakeholders in implementing public health strategies.

# 02 Food Industry Solutions

## Salt

### Salt Functionality

#### **Preservation**

Salt is a widely used food additive for preservation. While it does not have direct antimicrobial properties, it reduces water activity, slowing microbial growth. High salt concentrations affect microorganisms through osmotic pressure but may also lower the nutritional value of preserved foods by depleting water-soluble vitamins and minerals. As a preservation method, salting alone is insufficient for ready-to-eat products and must be combined with other techniques like drying or osmotic dehydration (Albarracín et al., 2011).

#### **Water-holding capacity & texture**

Salt plays a crucial role in improving the water-holding capacity of foods by interacting with proteins and modifying their ability to retain moisture. This helps maintain juiciness and prevents excessive moisture loss, which is particularly important in processed meats, dairy products, and baked goods (Albarracín et al., 2011). In meat products, salt helps with protein solubilisation and gel formation, contributing to a firmer texture (Desmond, 2006). In baked goods, it strengthens gluten networks, improving dough elasticity and structure (Silow et al., 2016). Additionally, in cheese production, salt plays a vital role in controlling moisture content and developing the desired texture (Guinee, 2004).

#### **Organoleptic**

Salt enhances flavour by influencing various biochemical mechanisms. It also affects enzymatic activity, either enhancing or reducing the function of certain enzymes that contribute to the development of different sensory attributes (De Man, 2023). Salt can suppress bitterness, enhance sweetness in some foods, and improve overall taste perception (Breslin & Beauchamp, 1997).

Table 3: Overview salt functionalities and sensory attributes (De Man, 2023).

Process/product functionalities	Sensory attributes
<b>Preservation</b> , primarily through reducing water activity.	Direct effect on <b>taste</b> i.e. salty.
Impacts the <b>water-holding capacity</b> of some meat products.	<b>Flavour enhancing</b> effect on other ingredients in food.
Breakdown of proteins for <b>maturation</b> of cheese.	Improves <b>texture</b> in bread, breakfast cereals, pickled vegetables, meat & cheese.

# Salt Reduction Solutions

## Gradual Salt Reduction

The following tables provide an overview of potential ingredient solutions for reformulation, distinguishing between nutritional and functional aspects. This distinction reflects the different objectives that may drive reformulation or innovation, such as improving the nutritional profile (e.g., reducing sugar, salt, or saturated fat) versus maintaining or enhancing product functionality (e.g., texture, stability, or shelf life). The tables are intended as a starting point for identifying possible solutions. They do not represent an exhaustive list, and additional considerations may apply depending on the specific product context and formulation goals.

Functional			Nutritional	
Solution	Benefits	Points of attention	Benefits	Points of attention
<b>(Gradual) Salt reduction</b>	Depending on the food product category, it is possible to take out 15-25% salt without further re-engineering the flavour profile of the recipe (de Man, 2023).	Microbial growth, requiring extra preservation for safety; May affect taste; May weaken protein interactions and water-holding capacity, impacting texture (de Man, 2023; Albarracín et al., 2011).	Reduces sodium intake, supporting cardiovascular health by lowering blood pressure and subsequently risk of gastric cancer, obesity, osteoporosis, Meniere's disease, and kidney disease (World Health Organization, 2023).	Potential risk of consumers compensating by adding more salt at home; Loss of iodine intake if salt is a primary iodine source in the diet, requiring alternative fortification strategies; Reduction steps should be spread over time (2-3 years) to ensure consumer acceptability (Hoppu et al., 2017).

# Mineral-based Salt Replacers

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
<b>Magnesium chloride</b>	Soups, sauces, bakery, dairy, fish and meat products	Enhances saltiness and contributes to texture and taste improvement; Can easily be combined with NaCl and KCl in various proportions (ratios) (Yang et al., 2024).	In high amounts identified as bitter; Less compatible in high water (bouillon) applications (ALQtaishat et al., 2022).	Essential mineral for muscle, nerve function and the vascular system (Souza et al., 2023).	High intake can cause digestive discomfort (laxative effect) (Dupont & Hébert, 2020).
<b>Magnesium sulfate</b>	Processed meats and dairy alternatives	Enhances saltiness and can contribute to texture improvement; Sometimes used in combination with KCl to enhance flavor and maintain functionality (Yang et al., 2024).	Potential bitter/metallic aftertaste at high concentrations (Ecarma & Nolden, 2021).	Essential mineral for muscle and nerve function (Refahée et al., 2022).	High intake can cause digestive discomfort (laxative effect) (Dupont & Hébert, 2020).
<b>Calcium salts (e.g., calcium chloride, calcium lactate)</b>	cheese, plant-based dairy, and canned vegetables	Provides a salty taste and can aid in food preservation (Kloss et al. 2015)	Potential bitter/metallic aftertaste at high concentrations (Ecarma & Nolden, 2021).	Contributes to bone health and muscle function (Trailoyke et al., 2017).	High intake may alter mineral balance in the body

## Mineral-based Salt Replacers (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Potassium chloride (KCl)</b>	Bread, cheese, and meat products	Provides salty taste similar to NaCl, widely used in low-sodium formulations (van Buren et al., 2016).	Potential bitter/metallic aftertaste at high concentrations (Ecarma & Nolden, 2021).	Helps reduce sodium intake, beneficial for blood pressure (Lu et al., 2022).	Excessive intake may affect kidney function, not suitable for individuals with kidney disease (Cupisti et al., 2018).

# Amino Acid and Peptide-Based Replacers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Yeast extracts</b>	Plant-based meat and soups	Contain glutamates and nucleotides that enhances umami flavor, reducing the need for added salt (Tomé, 2021).	May contribute to off-flavors (Tomé, 2021).	Naturally contains B vitamins and amino acids (Tomé, 2021).	Some consumers may avoid it due to concerns over glutamates (Voedingscentrum, n.d.-c).
<b>Hydrolyzed vegetable proteins (HVPs)</b>	Processed sauces and meat substitutes	Provides a strong umami taste, useful in processed foods (Wang et al., 2025).	May contribute to off-flavors (Wang et al., 2025).	Source of amino acids and protein (Wang et al., 2025).	Can introduce allergens depending on the source (e.g., soy, wheat) (Wang et al., 2025).
<b>Monosodium glutamate (MSG) and disodium inosinate/guanylate (I+G)</b>	Sauces, ready meals, and snacks	Strong umami enhancer, effective in small amounts; Can reduce the perception of salt reduction (Maluly et al., 2017).	Some consumers may be sensitive to MSG (e.g., "Chinese restaurant syndrome" concerns) (Maluly et al., 2017).	Reduces overall sodium intake while maintaining flavor (Maluly et al., 2017).	Perceived negatively by some consumers despite scientific consensus on safety (Wang, 2018).

# Plant and Algae-Based Salt Replacers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Seaweed and algae extracts (e.g., dulse, kelp, spirulina)</b>	Plant-based seafood alternatives, soups, and seasonings	Naturally salty and rich in umami, enhances food flavor (Ścieszka & Klewicka, 2019; Gullón et al., 2021).	Can contribute to a fishy or seaweed-like taste if overused (Figuerola et al., 2023).	High in iodine, essential minerals, and antioxidants (Circuncisão et al., 2018; Lozano et al., 2020).	Excessive iodine intake can affect thyroid function; Capacity to accumulate several toxic metals (Lozano et al., 2020; Circuncisão et al., 2018).
<b>Herb and spice blends</b>	Bakery, dairy, and snack products	Provides a range of flavors, reducing the reliance on salt (e.g., garlic, onion, celery, and citrus extracts) (Petersen et al., 2024).	Flavor profile may not fully mimic salt, requiring recipe adjustments (Petersen et al., 2024).	Adds phytonutrients and antioxidants (Drewnowski, 2024).	Some herbs/spices may trigger allergies or intolerances (Śmiechowska et al., 2021).

# Fermented and Enzymatically Modified Ingredients

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Fermented soy, miso, and koji extracts</b>	Plant-based and fermented foods (e.g., tempeh, plant-based cheese)	Adds depth and complexity to flavours, mimicking saltiness (Rysová & Šmídová, 2021).	Can contribute additional fermentation-related flavors (Lin et al., 2021).	Rich in probiotics and beneficial compounds (Jang et al., 2021).	May contain naturally occurring sodium (Lin et al., 2021).
<b>Enzyme-treated dairy proteins</b>	Cheese and dairy	Enhances umami and salt perception in dairy and alternative products.	Limited application outside of dairy-based products.	Source of protein and essential amino acids (Patel, 2015).	Not suitable for individuals with dairy allergies (Jaiswal & Worku, 2022).

# Encapsulated or Modified Sodium-Based Replacers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Salt microspheres</b>	Bakery, snack, and processed meat	Enhances salt perception while lowering total sodium use (Dordević et al., 2017).	May require formulation adjustments for even distribution. Processing method may affect cost and availability (Dordević et al., 2017).	Helps maintain taste while reducing sodium intake (He & Tan, 2024).	
<b>Nano-salt or salt crystals with enhanced surface area</b>	Bakery and processed food	Improves saltiness perception with reduced sodium (Vinitha et al., 2021).	Requires specialised processing technology and in some cases regulatory approval.	Reduces sodium intake while preserving taste (Vinitha et al., 2021).	Consumer perception of "nano" ingredients may affect acceptance (Gómez-Llorente et al., 2022).

# Electrolyte-Based Flavour Enhancers

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
Lactates and gluconates	Processed meats and sports nutrition	Maintains saltiness perception while reducing sodium (Ma et al., 2024).	Can have a slight sour or off-note in some applications (Ma et al., 2024).	Contribute to electrolyte balance and hydration (Li et al., 2022b).	Can cause digestive discomfort when consumed in large amounts.

# 03 Ingredient Suppliers Salt

## Functional Ingredient Suppliers

An extensive (not exhaustive) overview of ingredients and ingredient suppliers is available in the linked **Google Sheets database**.

Connect with ingredient suppliers within the [Healthier Food Community](#):

dsm-firmenich ●●●

DUTCH  
SPICES

MCLS EUROPE  
A subsidiary of Mitsubishi Corporation Life Sciences Limited

  
NEDMAG

SALTWELL®

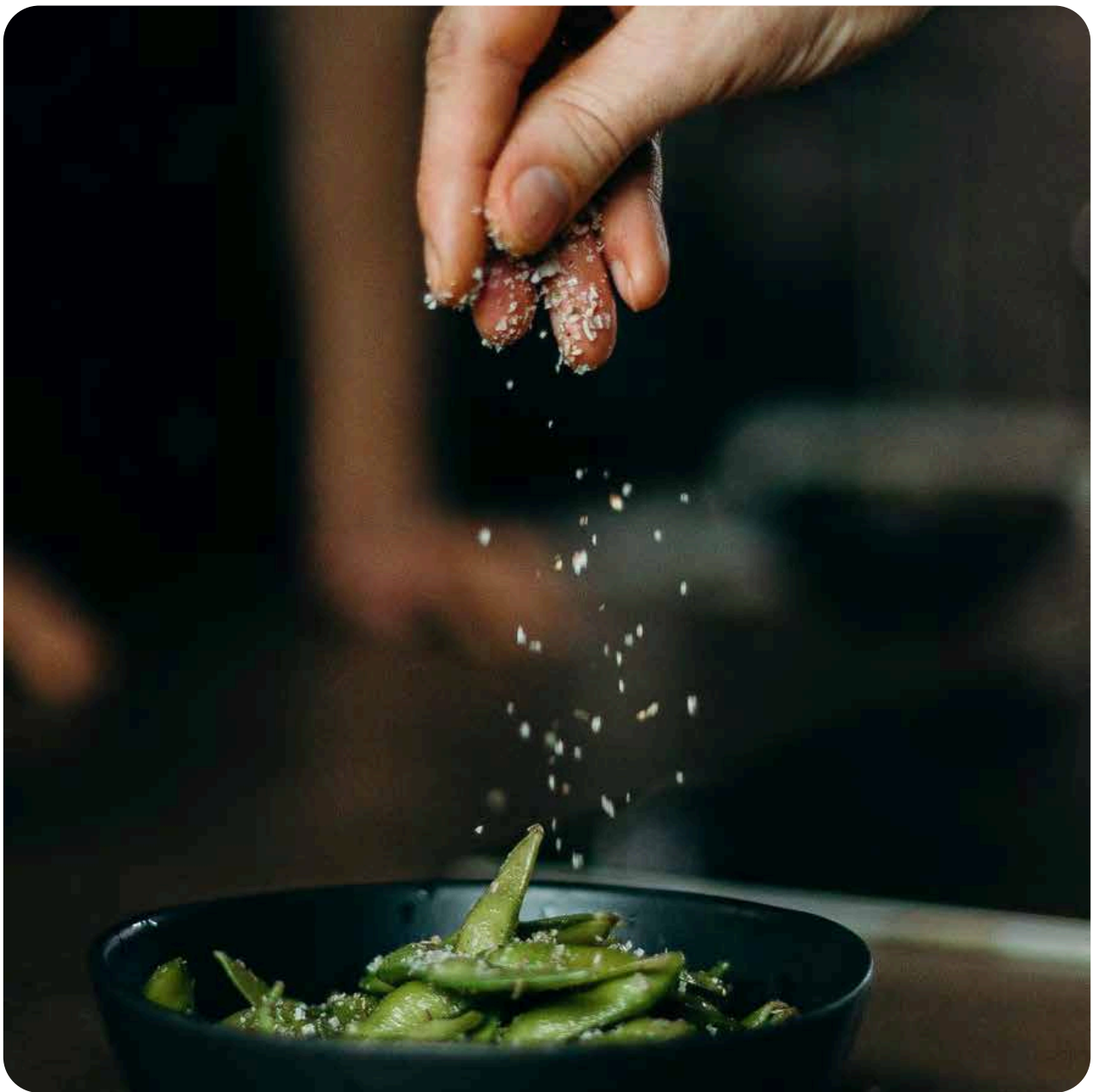
1·2taste\*

\*Ingredient marketplace for food manufacturers

Are you missing any information, suppliers or ingredients?  
Please contact **healthierfood@foodvalley.nl** and we can  
incorporate this in our next version.

# 04 Case Studies

## Salt



# Achieving nutri-score A for Mr. Kitchen's veggie spreads: A sodium reduction success story



## What challenge was faced?

The challenge was to improve the Nutri-Score of Mr. Kitchen's Veggie Spreads, moving them from Nutri-Score C to Nutri-Score A. Despite being packed with vegetables and legumes, these spreads were competing in a category dominated by chocolate spreads, fruit spreads, and chocolate sprinkles, making it essential to highlight their healthier profile.

## How was the problem solved?

A detailed analysis revealed that the positive nutritional drivers, such as veggies, protein, and fibre, were already contributing to a strong score. The key to achieving Nutri-Score A was reducing sodium content by lowering the percentage of sodium chloride (NaCl) while maintaining taste and quality.

## Were there any obstacles?

Determining the optimal percentage of Magnesium Salt that maximised sodium reduction while enhancing the product's taste and texture.

## What was the outcome?

We discovered Pure Health & Earth's Magnesium Solution, a natural, healthy salt alternative without the harmful sodium component. In less than a year from our initial introduction to production, we successfully achieved Nutri-Score A by reducing sodium levels by 30% and incorporating Magnesium Salt, which simultaneously enhanced the depth and umami of the spreads' flavour.

## Key takeaways and lessons learned

There is a viable alternative to sodium chloride as a flavour enhancer, Pure Health & Earth's Magnesium Salt. It enables sodium reduction while maintaining great taste and functionality.

## For more details, contact:



Wilfred Lijnbach  
W.Lijnbach@Nedmag.nl

“

With Pure Health & Earth's Magnesium Salt, we reduced sodium without compromise—proving that better nutrition and delicious flavour can go hand in hand.”

# Sodium reduction in salted crackers

The logo for SALTWELL, featuring the word "SALTWELL" in a green, sans-serif font with a registered trademark symbol, set against a white circular background.

## What challenge was faced?

Company A's salted cracker, containing 2% salt, was rated lower in consumer tests than a competitor's cracker with 2.5% salt. Company A aimed to enhance the salty flavour while reducing sodium content to 1.7%, the lowest limit set by NAPV for processed foods.

## How was the problem solved?

The solution was to replace regular salt with 2.5% Saltwell, a natural, reduced-sodium salt containing 35% less sodium than standard salt but offering the same salty flavour.

## Were there any obstacles?

Operational manager brought up the fact that this change resulted in a slightly higher cost in use. But the marketing- & sales department overruled this objection because they expect better sales and contribution because of improved flavour and nutrition.

## What was the outcome?

The reformulated cracker delivered a flavour profile comparable to the competitor's 2.5% salt version. Company A achieved a reduced sodium content of just 1.65%, successfully meeting both taste and nutritional goals.

## Key takeaways and lessons learned

In the case above, Saltwell is used to improve the salty taste while reducing sodium levels. Saltwell is a natural reduced-sodium salt with 35% less sodium compared to regular salt but with the same salty flavour profile in food applications.

## For more details, contact:



Tim Piels  
tim@saltwellsalt.com

“

Saltwell is used to improve the salty taste while reducing sodium levels.”

# Salt reduction in meat alternatives



## What challenge was faced?

The challenge was to reduce salt content in meat alternatives with 15% without compromising taste experience or consumer preference.

## How was the problem solved?

Functional citrus- and apple fibre enhanced texture and increased juiciness by 11%, resulting in an amplified perception of saltiness.

## Were there any obstacles?

The production process was key. Applying shear force (e.g, bowl chopper) was essential to optimise the performance of citrus fibre in achieving the desired texture and mouthfeel.

## What was the outcome?

Salt content was successfully reduced by 25%. The improved bite and juiciness from citrus fibre, combined with tailored spice and herb blends, ensured the final product delivered on both taste and texture.

## Key takeaways and lessons learned

Functional fibres, such as citrus or apple fibre, serve multiple roles, enhancing taste, improving flavour release, and supporting salt reduction. They are a valuable tool in creating great-tasting, clean-label meat alternatives.

## For more details, contact:



Noa Bastiaans  
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“

Functional citrus- and apple fibre enhanced texture and increased juiciness by 11%, resulting in an amplified perception of saltiness.

# Salt reduction in meat products



## What challenge was faced?

While processed foods are convenient for consumers, their contribution to a healthy diet is often limited, by e.g. high salt content. VION Food Group set out to lower the salt content in meat products for the British market by 30%.

## How was the problem solved?

NIZO tackled this challenge with a blend of technologies. A high-throughput (HTP) screening method was used to identify the most promising salt-replacement systems. This was followed by Olfactoscan screening to detect saltiness-enhancing aromas in meat extracts. The result: a well-balanced mix of salt replacers, masking agents, enhancers, and flavourful aromas that recreated the familiar salty taste.

## Were there any obstacles?

Salt plays multiple roles beyond flavour—it influences shelf life, moisture retention, and even texture. Reducing it meant addressing these functions all at once. By combining ingredient knowledge with advanced screening tools, NIZO was able to overcome these hurdles without increasing production costs significantly.

## What was the outcome?

More than 30% reduction in salt, 0% compromise on taste and shelf life. In two years, VION Food Group has taken more than 800 tonnes of sodium chloride out of gammon and bacon for the UK market.

## Key takeaways and lessons learned

This case shows that a structured, science-based approach can yield big wins in reformulation.

## For more details, contact:



Susann Bellmann  
Susann.bellmann@nizo.com  
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“

More than 30% reduction in salt, 0% compromise on taste and shelf life. In two years, VION Food Group has taken more than 800 tonnes of sodium chloride out of gammon and bacon for the UK market.”

# Sodium reduction in extruded savoury snacks

1.2 **taste**

## What challenge was faced?

A 50% sodium reduction was needed in extruded savoury snacks containing 1.2% salt. As most salt was applied via seasoning, many alternative solutions compromised flavour or introduced off-notes (bitter/metallic off-notes). The product also had to remain clean label and consistent across a wide flavour range under the same brand.

## How was the problem solved?

The problem was solved by replacing 50% of the salt with NuTek's Beyond Sea Salt in both the dough and the seasoning. So the new recipe was 0,6% salt and 0,6% NuTek Beyond Sea Salt. NuTek's Beyond Sea Salt can be labelled as Sea Salt.

## Were there any obstacles?

No problems occurred during the entire process. NuTek Beyond Sea Salt works very well in both the dough and the seasoning, giving full salty flavour without off-notes.

## What was the outcome?

The outcome was a range of extruded snacks with only 0.6% salt, so a reduction of 50% of an already low salt content, with a similar taste as the original. Also the reduction was very simple and various recipes of the snack seasonings could be reduced to the desired level. The product can also be labelled as Sea Salt.

## Key takeaways and lessons learned

In this case NuTek's Beyond Sea Salt is used to even further reduce products with already a low salt content without affecting the taste and properties of the final product. NuTek's Beyond Sea Salt proves to be an easy and very flexible solution in recipes with already pretty low salt contents. Similarly, NuTek's 'Salt for Life' is capable of achieving significant sodium reductions in already low salt recipes without compromising taste, functionality and microbiological stability.

## For more details, contact:



Walter Blom

[walter.blom@12taste.com](mailto:walter.blom@12taste.com)

“

NuTek's Beyond Sea Salt is capable of achieving significant sodium reductions in already low salt recipes without compromising taste and with a clean label.”



# Sugar

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## General information

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- Health Aspects
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## Food Industry Solutions

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# 01 General Information Sugar

## Background

Sugar, or saccharose, belongs to the family of carbohydrates. In the EU legislation, the term 'carbohydrates' refers to 'any carbohydrate which is metabolised by humans, and includes polyols' (European Commission, 2023b). European Union legislation refers to sugars as 'all monosaccharides and disaccharides present in food, but excludes polyols', while foods with no added sugars are defined as foods without 'any added monosaccharides or disaccharides', or without 'any added food containing monosaccharides or disaccharides which is used for its sweetening purposes' (Table 4) (European Commission, 2023b).

In this report, 'sugar' refers to monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars present in honey, syrups, fruit juices and fruit juice concentrates (Figure 2).

The **intake** of total sugars of different European countries is published by the European Commission (European Commission, 2021), total sugars range between 15 and 21% of energy intake (Azaïs-Braesco et al., 2017). In the Netherlands the Voedsel Consumentie Peiling of 2019-2021 has found an average intake of mono- and disaccharides of 92 g/day, amounting to 19% of total energy intake (RIVM, 2021a).

The main **sources** of mono- and disaccharides intake in the Netherlands are: dairy and dairy substitutes (20%), fruits, nuts and olives (19%), non-alcoholic beverages (15%), confectionery (15%) and biscuits and cakes (11%) (RIVM, 2021a).

Table 4: Types of sugar, examples and sources (Turck et al., 2023; European Commission, 2023).

Class	Description	Amount of sugar molecules	Examples
<b>Sugar</b>	Monosacharides	One sugar molecule	Glucose, galactose, and fructose
<b>Sugar</b>	Disaccharides	Two sugar molecules	Sucrose, lactose, and maltose
<b>Polysaccharides</b>	Starches and non-starch polysaccharides	Multiple sugar molecules	Amylose, cellulose, and pectins

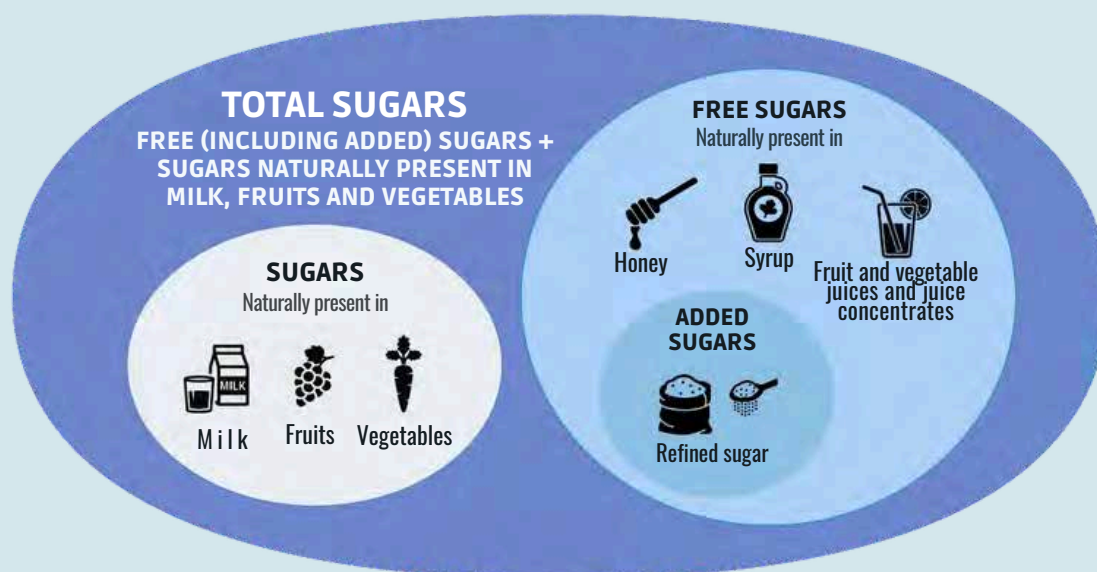


Figure 2: Classification of dietary sugars (Turck et al., 2022).

# Health Aspects



## INCREASED RISK OF CARDIOVASCULAR DISEASES

Research has linked diets rich in sugary and ultra-processed foods to heart disease risk factors (European Commission, 2023b). Additionally, foods high in added sugar often contain high amounts of saturated fat.

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## INCREASED RISK OF OBESITY

Processed foods high in sugars have been associated with unintentional weight gain or obesity (European Commission, 2023b). While some evidence suggests that high sugar intake, particularly from sugar-sweetened beverages, is associated with increased obesity risk, other research questions this link, especially for solid sugars (Yan et al., 2022).

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## INCREASED RISK OF POOR DENTAL HEALTH

Evidence suggests that frequently consuming sugar can negatively impact your dental health (European Commission, 2023b). Bacteria in the mouth thrive on sugar, producing acids that erode the enamel protecting the teeth, which can lead to cavity formation over time (European Commission, 2023b).

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## INCREASED RISK TYPE 2 DIABETES

Research indicates that higher intake of added sugars, particularly from sugar-sweetened beverages, is linked to an increased risk of type 2 diabetes in adults (Ma et al., 2022b; Meng et al., 2021). Scientists agree that high levels of sugar consumed daily increase inflammation along with decreased insulin sensitivity (Ma et al., 2022b), potentially causing blood sugar imbalances and the development of type 2 diabetes (European Commission, 2023b; Banday et al., 2020).

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# Regulatory Framework

## Dietary Guidelines

**WHO** recommends limiting intake of free sugars throughout the life course. In both adults and children, WHO recommends limiting the daily intake of free sugars to less than 10% of total energy intake, and to less than 5% if possible (European Commission, 2023b).

Similarly, in Europe, different nutrition and health-related organisations have recommended to set an upper limit of daily energy (calorie) intake of (added/free) sugars (European Commission, 2023b). However, **EFSA** has not set an upper limit for recommended dietary intake of sugar (European Commission, 2023b).

In the **Netherlands** there is also no governmental guideline for sugar intake. The **Dutch Health Council** states there is no sufficient evidence to establish a separate maximum for consumption (Voedingscentrum, n.d.-d).

### WHO recommendation of free sugar intake per day



< 10% energy  
intake per day

### EFSA and Dutch recommendations of free sugar intake per day



No upper  
limit set

## Nutrition claims

Allowed claims in EU (European Commission, 2023b):

- **Sugar-free:** may only be made where the product contains no more than 0,5 g of sugar per 100 g or 100 ml.
- **Low sugars:** may only be made where the product contains no more than 5 g of sugars per 100 g for solids or 2,5 g of sugars per 100 ml for liquids.
- **No added sugars:** may only be made where the product does not contain any added mono- or disaccharides or any other food used for its sweetening properties.

## Nutri-Score

The lower sugar limit used by Nutri-Score is  $\leq 4,5$  g sugar (excluding drinks) per 100 g of product. Nutri-Score assigns negative points for sugar based on the quantity present in 100 g or 100 ml of the product, up to 10 negative points can be given for products containing 45 g or more of sugar per 100 g (RIVM, 2024).

In the Netherlands, RIVM has provided a [calculation tool](#) for the Nutri-Score of a product.

## NAPV

For sugar, the NAPV established limit values for multiple product categories, with for each product category specification in subcategories. When possible, the lower limits of the NAPV correspond to the lowest cut-off points of Nutri-Score. Consult the NAPV [source document](#) for detailed values applicable to specific products (RIVM, 2022).

NAPV developed limit values for for mono- and disaccharides in the following product categories:

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Bread(replacements) and breakfast cereals | <input type="checkbox"/> Spreads and cooking fats          |
| <input checked="" type="checkbox"/> Dairy and plant-based alternatives        | <input type="checkbox"/> Soups and bouillons               |
| <input type="checkbox"/> Cheese   | <input type="checkbox"/> Sauces                            |
| <input type="checkbox"/> Meat preparations and meat products                  | <input checked="" type="checkbox"/> Savoury snacks         |
| <input type="checkbox"/> Deli meats and preserved meats                       | <input checked="" type="checkbox"/> Pastry & confectionary |
| <input type="checkbox"/> Fish   | <input checked="" type="checkbox"/> Drinks                 |
| <input type="checkbox"/> Meat substitutes                                     | <input type="checkbox"/> Sandwich filling                  |

Learn more: [NAPV roadmap](#)

# Further Readings



## **Beyond Sweetness: The Functional Roles of Sugar in Foods and the Challenges in Replacing/Reducing It (2016)**

An informational document on the role of carbohydrates, including sugar, in nutrition and food formulation. It discusses their functional properties, impact on health, and industry perspectives on sugar reduction.

## **EUR-Lex Regulation (EC) No 1924/2006 on Nutrition and Health Claims**

This legislation provides the legal framework for nutrition and health claims made on foods within the EU. It specifies the conditions under which claims like "low sugar" can be made, ensuring that consumers receive truthful and substantiated information.

## **Reformulation of food and beverage products for healthier diets: WHO policy brief**

Provides information and practical guidance for implementing effective policy actions to eliminate industrially produced trans-fatty acids from the food supply, reduce the energy content per portion and lower the levels of saturated fats, sugars and salt/sodium in food.

## **Strategies for the Reduction of Sugar in Food Products – ScienceDirect (2023)**

A scientific overview of different methods used to lower sugar content in food products while maintaining quality. The article reviews ingredient substitutions, technological processes, and regulatory considerations.

## **Technical Brief: Food Reformulation for Sugar**

Examines the health implications of high sugar intake and identifies major dietary sources contributing to excessive consumption. It emphasizes the importance of product reformulation to reduce sugar levels in processed foods and discusses strategies for achieving this goal.

## **Use of non-sugar sweeteners: WHO guideline (2023)**

This guideline offers evidence-based advice on non-sugar sweeteners to support policymakers, health professionals, and stakeholders in reducing sugar intake through public health actions and interventions.

# 02 Food Industry Solutions Sugar

## Sugar Functionality

### **Preservation**

Sugar preserves food by drawing water out of microbial cells, dehydrating them through osmotic pressure. Sugar also binds water molecules, reducing water activity and inhibiting microbial growth, thereby extending shelf life (McCain et al., 2018). Reduced sugar can lead to higher water activity, encouraging microbial growth and leading to spoilage and faster drying out, impacting the freshness of the product (McCain et al., 2018; Efe & Dawson, 2022).

### **Volume and bulk**

Sugar contributes to the structure and volume of baked products by creating air pockets during creaming with fats, while also adding to the overall mass of the product. Reducing it often requires substitutes to maintain texture (McCain et al., 2018).

### **Texture and mouthfeel**

Sugar retains water, influencing the viscosity and crispness of food (van der Sman et al., 2021). This affects the texture (moist and chewy) of baked goods (van der Sman et al., 2021). Reducing sugar can result in a drier, denser texture or an undesirable chewy, hard, or grainy texture (McCain et al., 2018).

### **Thermal processing**

When sugar undergoes thermal processing, its functionality changes depending on temperature, time, moisture content, and the presence of other ingredients (van der Sman et al., 2021). These changes impact texture, flavour, colour, and stability in food product reformulation. Sugar also lowers freezing points in frozen products, requiring alternatives like polyols or short-chain oligosaccharides to maintain desired properties (Landikhovskaya & Tvorogova, 2021).

## Organoleptic

Sugar not only adds sweetness but also enhances overall flavour perception by masking bitterness and balancing acidity (McCain et al., 2018). Reducing sugar may make these other flavours more prominent. It also affects the timing and intensity of sweetness, requiring careful selection of alternatives with similar profiles (McCain et al., 2018).

Additionally, sugar contributes to browning through the Maillard Reaction and caramelisation (McCain et al., 2018). Reducing sugar may diminish browning, affecting flavour and appearance, especially affecting baked products (Tamanna & Mahmood, 2015). Alternative reducing sugars or Maillard mimetics can help retain these properties (McCain et al., 2018).

## Mesh size

Size and type of sugar crystals influence texture, solubility, binding efficiency and processing properties (van der Sman, 2019). Fine sugar crystals create smooth textures (e.g. fondant) through rapid solubility and better dispersion. Larger crystals add crunch (e.g. cookies). Larger crystals also have better heat resistance and improve stability in dry blends. Alternative bulking agents may alter these characteristics (van der Sman, 2019).

Table 5: Overview sugar functionalities and sensory attributes.

Process/product functionalities	Sensory attributes
<b>Texture</b> , sugar affects the texture of a product, where a reduction can result in undesirable properties.	<b>Sweetness</b> , sugar reduction may alter the onset, intensity, and duration of sweetness.
<b>Volume and bulk</b> , sugar contributes to the structure and volume of products.	<b>Organoleptic properties</b> should be carefully considered in product formulation to obtain the desired qualities.
<b>Preservation</b> , sugar acts as a preservative and can help extend shelf life.	<b>Mesh size</b> , influences texture, solubility, and functionality of the sugar.
<b>Stability</b> of a product is highly dependent on type, temperature, and concentration of sugar.	<b>Thermal processing</b> can affect colour and functionality of sugar and alternatives.

# Sugar Reduction Solutions\*

\*If based in the Netherlands, ensure use of sweeteners is in line with the legislation on additives currently in force (Nederlandse Voedsel- en Warenautoriteit, 2024b)

The following tables provide an overview of potential ingredient solutions for reformulation, distinguishing between nutritional and functional aspects. This distinction reflects the different objectives that may drive reformulation or innovation, such as improving the nutritional profile (e.g., reducing sugar, salt, or saturated fat) versus maintaining or enhancing product functionality (e.g., texture, stability, or shelf life). The tables are intended as a starting point for identifying possible solutions. They do not represent an exhaustive list, and additional considerations may apply depending on the specific product context and formulation goals.

## Sugar Reduction

Functional			Nutritional	
Solution type	Benefits	Points of attention	Benefits	Points of attention
<b>(Gradual) Sugar reduction</b>	Maintains product acceptability while slowly reducing sugar content; allows consumers to adjust to less sweetness over time (Hashem et al., 2019).	May require multiple iterations to achieve desired sensory properties; Potential for consumer resistance if changes are too noticeable (Ma et al., 2016).	Reduces overall sugar intake; Helps in managing calorie consumption and reducing the risk of sugar-related health issues (Ma et al., 2016).	If not managed properly, may lead to the use of alternative ingredients that could have other health implications (Ma et al., 2016).

# Natural Sweeteners

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Stevia</b> (Steviol Glycosides)	Dairy products, confectionery	200-300× sweeter than sugar; heat-stable for baking and beverages (Paola et al., 2023).	Requires blending for balanced sweetness. Still needs bulking agents in sugar replacement (Nur et al., 2021).	Zero glycemic impact; safe for diabetics (Paola et al., 2023).	Some people may experience a bitter or licorice-like lingering aftertaste (Paola et al., 2023).
<b>Monk fruit*</b>	Confectionery, protein bars, and dairy products	250× sweeter than sugar (Yeung, 2023).	Some variants may have a fruity or slightly caramel-like aftertaste (Yeung, 2023).	Zero glycemic impact; safe for diabetics (Kaim & Labus, 2025).	Limited supply and higher production costs (Wazir et al., 2025).

\*Non-selective water extracts of the whole fruit are approved for use in the EU as traditional food ingredients. Whereas, monk fruit extract sweeteners are not approved and pending further safety evaluations and regulatory approval (EFSA Panel on Food Additives and Flavourings (FAF) et al., 2019)

# Artificial Sweeteners

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Aspartame</b>	Soft drinks, dairy products	180–200× sweeter than sugar; Taste close to sucrose (Czarnecka et al., 2021).	Not heat-stable; Breaks down at high temperatures (Czarnecka et al., 2021).	Zero glycemic impact; Safe for diabetics (Shaher et al., 2023).	Contains phenylalanine – unsafe for individuals with PKU (phenylketonuria) (Shaher et al., 2023).
<b>Sucralose</b>	Baked goods, dairy products	600× sweeter than sugar; Heat-stable for baking and cooking (Singh et al., 2024b).	Some consumers report a slight aftertaste; May not caramelize like sugar (Singh et al., 2024b).	Zero glycemic impact; Safe for diabetics (Aguayo-Guerrero et al., 2024).	May alter gut microbiota in excessive consumption (Aguayo-Guerrero et al., 2024).
<b>Saccharin</b>	Beverages	300–400× sweeter than sugar; Highly stable in acidic products (Souza et al., 2022).	Metallic or bitter aftertaste; Often blended with other sweeteners (Souza et al., 2022).	Zero glycemic impact; Safe for diabetics (Del Pozo et al., 2022).	Some consumers avoid it due to past unvalidated concerns (Castle et al., 2024).
<b>Acesulfame K</b>	Beverages, baked goods, dairy products	200× sweeter than sugar; Highly heat-stable (Castle et al., 2025).	Bitter aftertaste if used alone; Often blended with sucralose or aspartame (Mehat et al., 2022).	Zero glycemic impact; Safe for diabetics (Mehat et al., 2022).	May alter gut microbiota in excessive consumption (Castle et al., 2025).

## Artificial Sweeteners (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Neotame</b>	Beverages, baked goods	7,000–13,000× sweeter than sugar; Heat-stable and suitable for industrial use (Farag et al., 2022).	Requires very low concentrations for sweetness, making formulation adjustments necessary (Ibrahim, 2015).	Zero glycemic impact; Phenylalanine content is too low to affect people with PKU (phenylketonuria) (Farag et al., 2022).	May alter gut microbiota in excessive consumption (Farag et al., 2022).
<b>Advantame</b>	Bakery, confectionery, dairy	20,000× sweeter than sugar; Ultra-high intensity sweetener (Silva et al., 2023).	Newer sweetener; Not as widely available in commercial consumer product.	Zero glycemic impact; Safe for diabetics (Iizuka, 2021).	Generally recognized as safe (GRAS) by the FDA and EFSA but long-term studies are limited (EFSA, 2013).

# Sugar Alcohols

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Erythritol</b>	Chocolates, sweets, beverages	70% as sweet as sugar; Provides bulk and texture (Ibrahim, 2021).	Cooling effect in mouth; May not fully replace sugar's caramelization properties (Mazi & Stanhope, 2023).	Almost zero calories (0.2 kcal/g); Does not spike blood sugar (Ibrahim, 2021).	High doses may cause bloating in sensitive individuals (Mazi & Stanhope, 2023).
<b>Xylitol</b>	Chewing gum, baked goods	Similar sweetness to sugar (1:1 replacement); Prevents moisture loss in baked goods (Umai et al., 2022).	May require adjustments in water activity control or blending with other sweeteners to prevent excessive moisture retention or crystallization (Radya Asasta et al., 2024).	Contains 2.4 kcal per gram, which is about 40% fewer calories than sugar (4 kcal/g) (Umai et al., 2022).	High intake can cause digestive discomfort (laxative effect) (Radya Asasta et al., 2024).
<b>Sorbitol</b>	candies, baked goods,	60% as sweet as sugar; Provides smooth texture (Li et al., 2022a).	Unlike sugar, Sorbitol does not participate well in the Maillard reaction or caramelization, affecting color and flavor development in baked goods (Yan et al., 2024).	Lower calorie content (2.6 kcal/g) compared to sugar (Li et al., 2022a).	High intake can cause digestive discomfort (laxative effect) (Radya Asasta et al., 2024).

## Sugar Alcohols (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Maltitol</b>	Chocolates, baked goods	90% as sweet as sugar; Provides similar mouthfeel and offers a smooth texture (Ding & Yang, 2021).	Has a slower crystallisation rate than sugar, additional tempering techniques or blending with other polyols may be necessary (DeJong & Hartel, 2020)	Lower calorie content (2.1 kcal/g) than sugar (Suna et al., 2023).	High intake can cause digestive discomfort (laxative effect) (Ding & Yang, 2021).
<b>Mannitol</b>	Candies, sweets	50–70% as sweet as sugar; Stable under high temperatures; Does not attract much water (Shrivastava et al., 2021).	Can make baked goods dry or crumbly, requiring additional binding agents (Sahin et al., 2018).	Low glycemic impact (Martínez-Miranda et al., 2022).	High intake can cause digestive discomfort (bloating) (Pessarelli et al., 2022).
<b>Isomalt</b>	Chocolate, confectionary	50% as sweet as sugar; Improves texture in sugar-free candies (Schweitzer et al., 2024).	Less sweetness than sugar; Can also cause a firmer or more brittle texture than expected (Schweitzer et al., 2024).	Low-calorie alternative (2 kcal/g) (Schweitzer et al., 2024).	High intake can cause digestive discomfort (laxative effect) (Świąder et al., 2022).

# Fibre Replacers

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
<b>Soluble Fibre replacers</b> (e.g. inulin, polydextrose)	See also fibre solutions	Dissolve in water and can create a gel-like texture, helping to improve mouthfeel and stability (Rodriguez-Garcia et al., 2022).	Can create slimy textures if overused, may be sensitive to temperature or pH changes (Mensink et al., 2015).	Increase dietary fiber content; Support digestive health; Aid in satiety, potentially assisting in weight management (Sempio et al., 2024).	Can cause gas or bloating when consumed in large amounts (Miller et al., 2015).
<b>Insoluble fibre replacers</b>	See also fibre solutions	provide bulk and structure to products, helping with texture and stability (Soleimanian et al., 2022).	Can make products crumbly or dry if not balanced correctly; Requires moisture adjustments (Sempio et al., 2024).	Supports digestive health, reduces post-meal glucose spikes (Sempio et al., 2024).	Can cause gas or bloating when consumed in large amounts (Miller et al., 2015).
<b>Polydextrose</b> (synthetic polymer of glucose)	Baked goods, confectionary, dairy	Acts as a bulking agent, stabilizer, and thickener; Provides body and texture to low-calorie foods (Ünal & Arslan, 2022).	May require additional ingredients to achieve desired sweetness; Can affect the taste profile if not used correctly (Ünal & Arslan, 2022).	Low in calories; Contributes to dietary fiber intake; May aid in digestive health (Ünal & Arslan, 2022).	Can cause gas or bloating when consumed in large amounts (Miller et al., 2015).

# Fermentation

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Lactic acid fermentation</b>	Dairy, beverages	Reduces sugar content in dairy (yogurt), vegetables (sauerkraut, kimchi), and beverages (kombucha) (Ozcan et al., 2021).	Live cultures may not survive heat processing, can alter taste by adding sourness, may require formulation adjustments (Janiszewska-Turak et al., 2024).	Increases probiotic content, supports digestion, enhances nutrient bioavailability (e.g., B vitamins) (Ozcan et al., 2021).	Some fermented products may still contain residual sugars, and excess acidity could affect tooth enamel and digestion in sensitive individuals.
<b>Enzymatic Fermentation</b>	Baked goods, cereals, and beverages	Breaks down starches into simpler, naturally sweet molecules for sugar reduction (Müller et al., 2021).	Needs precise enzyme control to avoid over-processing, which may impact texture (Raveendran et al., 2018).	Reduces the need for added sugars while maintaining sweetness (Müller et al., 2021).	Some enzymes may be denatured by high heat, affecting efficiency (Haspolat, 2024).

# Novel Sweeteners

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
<b>Allulose*</b>	Baked goods, confectionery	Provides bulk, texture, and freeze-thaw stability similar to sucrose (Xie et al., 2024).	Browns faster than sucrose, can lead to excessive browning or burning if not adjusted (Xie et al., 2024).	Very low in calories (~0.4 kcal/g) – ~90% fewer calories than sugar, making it useful for calorie reduction (Xie et al., 2024).	Can cause gas or bloating when consumed in large amounts (Miller et al., 2015).
<b>Tagatose</b>	beverages, dairy, and baked goods	Provides bulk and mouthfeel similar to sugar. Enhances browning and caramelization (Ortiz et al., 2024).	Can degrade under prolonged high temperatures, potentially affecting stability in heated applications (Bober & Nair, 2019).	Low calorie (~1.5 kcal/g) – ~60% fewer calories than sucrose, making it useful for calorie reduction (Ortiz et al., 2024).	Can cause gas or bloating when consumed in large amounts (Ortiz et al., 2024).
<b>Trehalose</b>	Baked goods, confectionary	Stabilizes proteins and lipids, helps preserve texture, moisture, and shelf life (Chen et al., 2022).	More expensive, and often needs blending with other sweeteners to match sugar's sweetness (Chen et al., 2022).	Metabolized more slowly than glucose, preventing rapid blood sugar spikes (Yoshizane et al., 2017).	Caloric content similar to sugar (4 kcal/g). Does not provide calorie reduction like other sugar alternatives (Chen et al., 2022).

\*Allulose is not approved for use in Europe as a food ingredient because it is classified as a "novel food. EFSA is currently evaluating allulose for potential use as a food ingredient.

# Novel Sweeteners (continued)

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
Stachyose	Beverages (including solid beverages), dairy products, baked goods, confectionery	With a sweetness of about 22% of sucrose, it can replace part of the sucrose to meet sweet taste demand; Good water-solubility and stable properties within a wide range of temperatures and pH values (Ta et al., 2024).	In foods with high sweetness requirements, it may be necessary to blend with other sweeteners and control the dosage to avoid affecting the food's flavor (Ta et al., 2024).	Prebtiotic; Low in calories (Yan et al., 2023).	Can cause gas or bloating when consumed in large amounts.

# 03 Ingredient Suppliers Sugar

## Functional Ingredient Suppliers

An extensive (not exhaustive) overview of ingredients and ingredient suppliers is available in the linked **Google Sheets database**.

Connect with ingredient suppliers within the [Healthier Food Community](#):

dsm-firmenich ●●●

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INGREDIENTS

**MCLS EUROPE**

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INNOVATION AS MAIN INGREDIENT

1·2**taste**\*

\*Ingredient marketplace for food manufacturers

Are you missing any information, suppliers or ingredients?  
Please contact **[healthierfood@foodvalley.nl](mailto:healthierfood@foodvalley.nl)** and we can  
incorporate this in our next version.

# 04 Case Studies

## Sugar



# Sugar and Salt reduction in Ketchup



## What challenge was faced?

The goal was to develop a ketchup with reduced sugar and salt by at least 30%, while maintaining the familiar taste and mouthfeel consumers expect.

## How was the problem solved?

Functional citrus and apple fibres were used to build texture and body, allowing for a reduction in both sugar and tomato purée. The open fibre structure enhanced flavour release, making it possible to cut salt without compromising taste.

## Were there any obstacles?

Reducing sugar and increasing water content can lead to syneresis (separation). The inclusion of citrus fibre helped stabilise the product and minimise this risk.

## What was the outcome?

A reduction of at least 30% in both sugar and salt was achieved, while preserving the expected mouthfeel. To maintain a balanced flavour, adjustments to herbs, spices, and vinegar levels were also made.

## Key takeaways and lessons learned

Citrus and apple fibres are powerful tools for reducing sugar and salt in sauces. They maintain texture and enhance flavour release, making them ideal for healthier product reformulations.

## For more details, contact:



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“

Citrus and apple fibres are powerful tools for reducing sugar and salt in sauces. They maintain texture and enhance flavour release, making them ideal for healthier product reformulations.”

# Sugar reduction in cookies

12taste

## What challenge was faced?

The goal was to reduce sugar content by 50% in baked sand dough cookies. Traditional sugar replacers often lack the bulk, browning behaviour, and recrystallization properties of sugar, making reformulation challenging.

## How was the problem solved?

The problem was solved by replacing 50% of the sugar with Anderson Advanced Ingredients Allsweet Allulose Crystals. Allulose is an all natural sugar replacer with only 10% of the calories compared to sugar but with similar bulk and baking properties.

## Were there any obstacles?

No problems occurred during the development process. The reformulated dough performed well in both preparation and baking.

## What was the outcome?

The cookies retained the original taste, texture, and bite, with 50% less sugar. The only adjustment was a 10% reduction in baking time, as Allulose browns faster due to its reducing sugar properties.

## Key takeaways and lessons learned

Allsweet Allulose is a highly effective sugar alternative for baked goods, offering similar bulk and baking functionality with significantly fewer calories. While still considered a novel food in the EU, it is already approved in many other markets and is expected to gain EU approval soon.

## For more details, contact:



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“

Allsweet Allulose from Anderson Advanced Ingredients is an excellent sugar replacer in many applications but is especially effective in baked applications due to similar bulk and baking properties as sugar.”



# Saturated Fat

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# 01 General Information

## Saturated fat

### Background

Dietary fat is an essential macronutrient that provides energy, supports cell growth, and helps the body absorb fat-soluble vitamins (A, D, E, and K). It plays a crucial role in hormone production, brain function, and maintaining overall health. WHO notes that both quantity and quality of fats are important for good health (Cattaruzza & French, 2024; World Health Organization, 2023c).

All fats are composed of molecules called fatty acids, which are chains of carbon atoms. There are different types of dietary fats, each with unique effects on the body. They comprise monounsaturated, polyunsaturated, saturated, and trans fatty acids. According to the EU Regulation 1169/2011 definition, 'saturated' means fatty acids without double bonds and 'unsaturated' includes fatty acids with one (mono-) or more (poly-) cis double bonds. Trans fats are unsaturated fatty acids that mostly come from industrial sources. They contain a double bond in trans- (instead of cis-) alignment (European Parliament and Council of the European Union, 2011). The different types of dietary fats, examples and main sources are explained in Table 6. This report focuses solely on saturated fats (SFA), in line with the NAPV guidelines.

Global SFA **intake** varies widely across countries, ranging from 2.3% to 27.5% of total energy intake, with a global average of 9.4% in 2010. In 75 of 187 countries representing 61.8% of the world's adult population, the mean intake was greater than 10% of total energy intake (Micha et al., 2014). SFA are primarily found in meats, meat products, and dairy products like butter, milk, and cheese. However, certain plant-based fats, such as cocoa butter, coconut oil, palm oil, and palm kernel oil (commonly known as tropical oils), are also high in SFA. These fats are widely used in various processed foods, including cakes, biscuits, and pastries (Cattaruzza & French, 2024).

The average **intake** of SFA in the Netherlands is 30 g/day, 13.3% of the daily energy intake. With an intake of 33 g/day it is higher for males than for females who consume 27 g/day. The contribution of SFA to energy intake is almost the same for boys/men and girls/women (13.1 and 13.5 En%/day). The main **sources** of SFA are dairy and dairy substitutes (34%), meat and meat substitutes (17%) and fats and oils (12%) (RIVM, 2021b).

Table 6: Types of dietary fat, examples and sources.

Type of fat	Description	Examples	Sources
<b>Mono-unsaturated fat</b> (Kris-Etherton, 1999)	Contains one double bond, beneficial for heart health	Oleic acid	Olive oil, canola oil, certain nuts, and avocados
<b>Poly-unsaturated fat</b> (Meyer et al., 2003)	Contains multiple double bonds, essential for body functions	Omega-3 (EPA, DHA) and Omega-6 fatty acids	Fatty fish, nuts, and plant-based oils
<b>Saturated fat</b> (World Health Organization, 2023c)	Contains single carbon-carbon bonds (i.e. no double bonds)	Lauric acid, Plmitic acid, Stearic acid	Fatty meat, dairy foods, and hard fats and oils such as butter, ghee, lard, palm oil and coconut oil
<b>Trans fat</b> (World Health Organization, 2023c; Alonso et al., 1999)	Unsaturated fatty acids with at least one double carbon-carbon bond in the trans configuration	Elaidic acid	Baked and fried foods, pre-packaged snacks, and meat and dairy foods from ruminant animals, such as cows or sheep.

# Health Aspects



## INCREASED RISK OF CARDIOVASCULAR DISEASES

A diet high in SFA has been associated with increased atherosclerotic cardiovascular disease risk, in large part because of an effect to raise the low-density lipoprotein cholesterol concentration. A high amount of low-density lipoprotein cholesterol is not good for the blood vessels because it contributes to plaque buildup in the arteries (Hu et al., 2001).

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## INCREASED RISK OF OBESITY

Consuming high amounts of SFA is associated with an increased risk of obesity, as these fats are energy-dense and can promote fat accumulation, particularly abdominal fat. Research has shown that SFA intake influences mechanisms of fat storage and appetite regulation, leading to excess weight gain and a higher risk of metabolic disorders (Risérus et al., 2009).

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## INCREASED RISK OF CANCER

High SFA intake has been linked to an increased risk of several cancers, including colorectal, breast, and prostate cancers. Mechanistically, SFA can promote cancer progression through pathways such as chronic inflammation and altered cell growth regulation (Mei et al., 2024).

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# Regulatory Framework

## Dietary Recommendations

The **WHO** and the **Dutch Health Council** recommend that consumed fat should primarily be unsaturated fatty acids, with no more than 10% of total energy intake coming from SFA (World Health Organization, 2023c; Gezondheidsraad, 2015).

**EFSA** recommends that SFA and trans fat intake should be as low as possible within the context of a nutritionally adequate diet (EFSA, 2010).

### WHO and Dutch recommendation for saturated fatty acid intake



≤ 10% of total  
energy intake

### EFSA recommendation for saturated fatty acid intake



As low as  
possible

## Health Claims

Allowed health claims in EU on SFA:

- **Low in saturated fats:** If SFA and the trans-fatty acids in the product together do not exceed 1.5 g/100 g and 0.75 g/100 ml. No more than 10% of the energy consists of SFA and trans fatty acids.
- **Free of saturated fats:** If the sum of SFA and trans fatty acids does not exceed 0.1 g/100 g or 0.1 g/100 ml (European Commission, 2006).

Allowed health claims in the EU on fats in general:

- **Low fat:** The fat content of the product is maximum 3 g/100 g or 1.5 g/100 ml. With the exception of semi-skimmed milk: 1.8 g/100 ml.
- **Fat-free:** The fat content of the product is a maximum of 0.5 g/100 g or 0.5 g/100 ml (European Commission, 2006).

## Nutri-Score

The lower SFA limit used by Nutri-Score is  $\text{SFA} \leq 1 \text{ g per } 100 \text{ g}$  of product, and SFA accounting for less than 10% of the total fat content. Nutri-Score assigns negative points for SFA based on the quantity present in 100 g or 100 ml of the product. Up to 10 negative points can be given for products with 10 g or more of SFA per 100 g (RIVM, 2024).

In the Netherlands, RIVM has provided a [calculation tool](#) for the Nutri-Score of a product.

## NAPV

The NAPV established limit values for multiple product categories, with specific subcategories defined for each. Consult the NAPV [source document](#) for detailed values applicable to individual products. When possible, the lower limits of the NAPV correspond to the lowest cut-off points that Nutri-Score uses (RIVM, 2022).

NAPV developed limit values for SFA in the following product categories:

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Bread(replacements) and breakfast cereals | <input type="checkbox"/> Spreads and cooking fats    |
| <input checked="" type="checkbox"/> Dairy and plant-based alternatives        | <input type="checkbox"/> Soups and bouillons         |
| <input type="checkbox"/> Cheese   | <input checked="" type="checkbox"/> Sauces           |
| <input checked="" type="checkbox"/> Meat preparations and meat products       | <input checked="" type="checkbox"/> Savoury snacks   |
| <input checked="" type="checkbox"/> Deli meats and preserved meats            | <input type="checkbox"/> Pastry & confectionary      |
| <input type="checkbox"/> Fish   | <input checked="" type="checkbox"/> Drinks           |
| <input type="checkbox"/> Meat substitutes                                     | <input checked="" type="checkbox"/> Sandwich filling |

Learn more: [NAPV roadmap](#)

# Further Readings



## **EU Framework for National Initiatives on Selected Nutrients**

Provides guidance for member states on reducing saturated fat intake among the population. It emphasizes the importance of designing food products to contain less SFA and encourages the use of healthier alternatives.

## **Regulation (EC) No 1924/2006 on Nutrition and Health Claims**

This regulation outlines the conditions under which nutrition claims, such as "low saturated fat," can be made.

## **Reformulation of food and beverage products for healthier diets: WHO policy brief**

Provides information and practical guidance for implementing effective policy actions to eliminate industrially produced trans-fatty acids from the food supply, reduce the energy content per portion and lower the levels of SFA, sugars and salt/sodium in food.

## **Recent trends in design of healthier fat replacers: Type, replacement mechanism, sensory evaluation method and consumer acceptance**

Examines the rising demand for low-fat foods, challenges in maintaining quality, and fat replacer development, covering their mechanisms, sensory evaluation, and consumer acceptance to guide healthier product production.

## **Saturated fatty acid and trans-fatty acid intake for adults and children: WHO guideline**

This guideline provides updated, evidence-informed guidance on the intake of SFA and trans-fatty acids to reduce the risk of diet-related noncommunicable diseases in adults and children, particularly cardiovascular diseases.

## **Technical Brief Food Reformulation for Fats**

This brief examines the health impact of dietary fats, the need to reduce SFA and trans fats, and strategies to maintain quality and consumer acceptance in reformulated foods.

# 02 Food Industry Solutions

## Saturated fat

### Fat Functionality

#### **Texture and mouthfeel**

SFA contribute to the creamy, smooth, and rich mouthfeel of food products, enhancing their sensory appeal. They provide lubrication, reduce dryness, and play a key role in delivering a satisfying eating experience. Additionally, SFA influence the melting behaviour of foods like chocolate and dairy products, creating a desirable texture transition when consumed (Rios, 2014).

#### **Structure & stability**

SFA provide essential structure and stability in food products by aerating batters, contributing to flakiness in pastries, and ensuring a firm yet flexible consistency in spreads and doughs. Their role in emulsification helps maintain uniformity in products like dressings and ice creams, preventing separation. The plasticity of SFA also determines the spreadability and workability of products during food processing (Rios, 2014; Cansell, 2005).

#### **Processing**

In food manufacturing, SFA play a crucial role in ensuring smooth processing by improving dough handling, extrusion, and moulding properties. Their heat stability allows for high-temperature applications like frying and baking, providing crispiness and a golden-brown finish. Fats, including SFA, also contribute to moisture retention, preventing dryness and improving the overall product consistency (Rios, 2014; Mamat & Hill, 2014; Kathleen, 1999).

## Preservation

SFA help extend the shelf life of food products by preventing moisture loss, maintaining product stability, and acting as a barrier against external influences. They also contribute to oxidative stability, reducing rancidity and preserving freshness. This makes them essential for maintaining product quality over time, particularly in baked goods, snacks, and processed foods (Rios, 2014; Vieira et al., 2015).

## Organoleptic

Fats, including SFA, are excellent carriers of fat-soluble flavours and aromas, intensifying the overall taste experience. They help distribute flavours evenly throughout the food, enhancing their richness and depth. Additionally, SFA can influence the release of flavours in the mouth, ensuring a longer-lasting and more enjoyable sensory experience in both sweet and savoury products (Rios, 2014).

Table 7: Overview SFA functionalities and sensory attributes.

Process/product functionalities	Sensory attributes
<b>Thermal stability</b> , high resistance to heat, making them ideal for frying and baking.	Direct effect on <b>taste</b> i.e. rich, smooth, and indulgent texture (e.g., in dairy, chocolate, and baked goods).
<b>Emulsification &amp; consistency</b> , help stabilize emulsions in products like mayonnaise and ice cream.	<b>Flavour carrier</b> , help dissolve and release fat-soluble flavours, enhancing overall taste perception.
<b>Aeration &amp; structure</b> in baked goods, essential in pastries, cakes, and biscuits for creating flakiness and volume.	Improves <b>texture</b> , solid or semi-solid consistency of products (e.g., butter, cheese, and chocolate).
More resistant to oxidation than unsaturated fats, reducing rancidity and extending <b>product shelf life</b> .	<b>Melting behaviour</b> , creating a desirable texture change when consumed (e.g., chocolate melting in the mouth).

# Saturated Fat Reduction Solutions

## Saturated Fat Reduction

The following tables provide an overview of potential ingredient solutions for reformulation, distinguishing between nutritional and functional aspects. This distinction reflects the different objectives that may drive reformulation or innovation, such as improving the nutritional profile (e.g., reducing sugar, salt, or saturated fat) versus maintaining or enhancing product functionality (e.g., texture, stability, or shelf life). The tables are intended as a starting point for identifying possible solutions. They do not represent an exhaustive list, and additional considerations may apply depending on the specific product context and formulation goals.

Functional			Nutritional	
Solution type	Benefits	Points of attention	Benefits	Points of attention
<b>(Gradual) Saturated Fat reduction</b>	Allows for the use of alternative ingredients (functional foods) to enhance product innovation; In certain baked goods and snacks, replacing SFA with structured unsaturated fats or emulsifiers can lead to a lighter, crispier texture (Alessandrini et al., 2021).	May impact the aeration, spreadability, and stability of food structures; May lead to separation issues in emulsified products; May impact the shelf life (O'Sullivan, 2020).	Improves product healthiness (Alessandrini et al., 2021).	Fat reduction can alter texture, mouthfeel, and sensory appeal (O'Sullivan, 2020).

# Lipid-Based Replacers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Mono- and diglycerides</b>	Margarine, bakery, spreads	Improve emulsification and prevent separation in processed foods (Kara & Bor, 2019; Melchior et al., 2024).	May not fully replicate the richness or creaminess and can be influenced by processing conditions (Loi et al., 2019).	Help reduce the overall SFA content in food products (Subroto, 2020).	Fatty acid composition is influenced by the oils for production. Depending on the source oil (e.g., soybean oil, palm oil, or canola oil), they may contain varying levels of SFA and unsaturated fats (Subroto, 2020).
<b>Structured lipids</b>	Dairy alternatives, nutrition bars	Improve oxidative stability and shelf life compared to regular vegetable oils; Can provide similar melting behavior to traditional SFA in some food products (Zhou et al., 2022).	Some structured fats may lack traditional fat mouthfeel (Zhou et al., 2022).	Reduce the overall calorie content of food products (Hong et al., 2023).	May raise questions among some consumers, especially in clean-label or natural food markets.

# Plant-Based Replacers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Avocado oils</b>	Cooking oils, dressings, and as a butter alternative in baking	Excellent for frying and sautéing and can also replace butter and lard in various applications (Cervantes-Paz & Yahia, 2021).	Varies flavour profile; It may alter texture in large quantities; Cost and availability; Stability over time (Cervantes-Paz & Yahia, 2021).	Rich in monounsaturated fats and antioxidants (Lin & Li, 2024).	High in calories (Voedingscentrum, n.d.-e).
<b>Nut oils</b>	Typically used in salad dressings, marinades	Can be used as emulsifiers, when combined e.g. lecithin; Some are high in mono-unsaturated fats, which are more resistant to oxidation than polyunsaturated fats (e.g. macadamia oil) (Fernandes et al., 2017; Geng et al., 2020; Prisacaru, 2016).	Flavor profiles can vary, which may affect taste in certain applications (Costa et al., 2024).	Often rich in monounsaturated and polyunsaturated fats (Fernandes et al., 2017).	Allergen concerns (Fernandes et al., 2017).

## Plant-Based Replacers (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Seed oils (e.g. flaxseed, rapeseed, sunflower seed)</b>	Cooking oils, salad dressings, snacks, and processed foods.	Some are high in mono-unsaturated fats, which are more resistant to oxidation than polyunsaturated fats and have a neutral flavour profile (Prisacaru, 2016).	Flaxseed oil has a low smoke point, limiting its use in high-heat cooking (Joshi et al., 2022).	High in polyunsaturated fats (Kapoor et al., 2021).	Many seed oils (e.g., sunflower oil, soybean oil, corn oil) are high in omega-6 fatty acids, which, when consumed in excess relative to omega-3s, may contribute to inflammation and imbalance in the omega-6 to omega-3 ratio (Kapoor et al., 2021; Mariamenatu & Abdu, 2021).

# Carbohydrate and Fibre Replacers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Cellulose Derivatives</b>	Low-fat spreads, dairy products, sauces, and dressings	Improve texture and mouthfeel, providing creaminess and viscosity similar to SFA (He et al., 2021).	May lead to a rubbery texture or an unnatural mouthfeel if used in excess.	Low in calories, high in fibre, promoting digestive health (Aziz et al., 2024).	May cause digestive discomfort (e.g., bloating) in some individuals when consumed in large quantities (Borkoles et al., 2022).
<b>Starch-Based Replacers</b>	Baked goods, sauces, soups, and dairy alternatives	Provide bulk, structure, and viscosity; Improve texture and mouthfeel (Lin et al., 2024).	May affect the product's texture if not used in the right formulation or if overused (Lin et al., 2024).	Low in calories (Chen et al., 2020).	High glycemic index, which could affect blood sugar levels (Lal et al., 2021).
<b>Gum &amp; hydrocolloids</b> (see table 'Emulsifiers & Stabilisers' for examples)	Dairy products, dressings, baked goods, and beverages	Form gels or thicken products to improve texture and stability (Pirsa & Hafezi, 2023).	Can alter texture if overused, leading to a slimy or unpleasant mouthfeel (Blok et al., 2023).	High in fibre (Kapoor et al., 2016).	Some gums may cause digestive discomfort, including bloating or gas (Borkoles et al., 2022).

## Carbohydrate and Fibre Replacers (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Maltodextrins</b>	Snacks, beverages, processed foods, and desserts	Provide a smooth mouthfeel and increase product volume, acting as a bulking agent or thickener (Hofman et al., 2016).	May affect the texture of products by making them more "starchy" or less smooth if used excessively (Valenzuela & Aguilera, 2015).	Low in calories (Grzelak et al., 2017).	High glycemic index, which could affect blood sugar levels (Hofman et al., 2016).
<b>Beta-glucans</b>	Cereal-based products, beverages, bakery, and snacks	Improve viscosity, texture, and moisture retention; Support gel formation (Ahmad & Kaleem, 2018).	May not provide the same level of mouthfeel or creamy texture as SFA and could affect product consistency (Ahmad & Kaleem, 2018).	High in soluble fibre (Herrera et al., 2016).	Could cause digestive discomfort in high amounts (Major et al., 2017).

# Protein Replacers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Milk protein</b>	Low-fat cheeses, yogurt, baked goods	Provide creaminess and structure (Akbari et al., 2019).	May affect the texture in certain formulations if used in excess (Akbari et al., 2019).	High-quality protein source (Goulding et al. 2020).	Not suitable for vegan or dairy-free diets and allergen concerns (Puglisi & Fernandez, 2022).
<b>Egg protein</b>	Low-fat mayonnaise, baked goods	Stabilize emulsions and add richness (Li et al., 2021; Razi et al. 2023).	May affect the texture in certain formulations if used in excess (Razi et al. 2023).	High-quality protein source (Puglisi & Fernandez, 2022).	Not suitable for vegan or dairy-free diets and allergen concerns (Puglisi & Fernandez, 2022).
<b>Soy protein</b>	Meat alternatives, dairy-free products	Enhance texture and binding properties (Thrane et al., 2017).	Potential flavour issues or a soy aftertaste that may need masking in formulations (Thrane et al., 2017).	High-quality protein source, suitable for vegan diets (Qin et al., 2022).	Allergen concerns (Wang et al., 2023).
<b>Gelatin &amp; collagen peptides</b>	Low-fat dairy, desserts, confectionery	Provide elasticity and creaminess (Tang et al., 2022).	Potential flavor issues or a soy aftertaste that may need masking in formulations (Amyoony et al., 2023).	Provides collagen, which may support skin, joints, and bone health (Zhao et al., 2021).	Not suitable for vegetarian/vegan diets (Tang et al., 2022).

## Protein Replacers (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Mycoproteins</b>	Meat alternatives	Provide a fibrous, meat-like texture (Ahmad et al., 2022).	Fermentation-related taste may require masking (Wei En Lim & Kay Chai Tay, 2024).	High in protein and fibre (Ahmad et al., 2022).	Some allergic reactions have been reported (Jacobson & DePorter, 2018).
<b>Microencapsulated Coconut Milk &amp; Pine Nut Protein Powder</b>	Instant cereal products, solid beverages, baked goods, seasoning	It has a high oil-carrying capacity, with an oil content of 30g per 100g; Can replace non-dairy creamers (Ngampeerapong et al., 2018).	After opening, it should be sealed to avoid moisture.	Suitable for people with lactose intolerance; Rich in medium-chain fatty acids; Has a reasonable fatty acid ratio (Sacks et al., 2017).	Allergen concerns (Mori et al., 2022).

# Emulsifiers & Stabilisers

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Guar Gum</b>	Sauces, ice cream, and salad dressings	Enhances texture and stability, provides smoothness and creaminess (Jayanthi et al., 2024).	Overuse may result in excessive viscosity or gumminess (Jayakody et al., 2022; Saha & Bhattachary, 2010).	High in fibre (Jayakody et al., 2022)	May cause digestive discomfort when used in large amounts (Major et al., 2017).
<b>Gum Arabic</b> (Acacia Gum)	Beverages, low-fat dressings, and ice cream	helps stabilize emulsions and improve viscosity in reduced-fat products (Prasad et al., 2022).	Can cause thickening or sliminess in high quantities (Jayakody et al., 2022; Saha & Bhattachary, 2010).	Low in calories, may have prebiotic effects (Jayakody et al., 2022).	May cause digestive discomfort when used in large amounts (Major et al., 2017).
<b>Xanthan Gum</b>	Beverages, salad dressings, sauces, baked goods	Improves texture, viscosity, and stabilises emulsions in fat-reduced products (Habibi & Khosravi-Darani, 2017).	Overuse can cause sliminess or unwanted viscosity (Jayakody et al., 2022; Saha & Bhattachary, 2010).	Low in calories, high in fibre (Jayakody et al., 2022)	May cause digestive discomfort when used in large amounts (Major et al., 2017).
<b>Pectin</b>	Jams, jellies, low-fat fruit-based desserts	Provides gelling and thickening properties, helping to maintain texture in fat-reduced foods (Freitas et al., 2021).	Overuse may lead to excessive gel formation or an overly firm texture (Kakino et al., 2017).	High in fibre (Adam et al., 2016).	May cause digestive discomfort when used in large amounts (Major et al., 2017).

## Emulsifiers & Stabilisers (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Lecithin</b>	Margarine, dressings, bakery, spreads	Stabilizes emulsions, enhances texture and spreadability (Alhajj et al., 2020).	Overuse may cause a waxy texture or separation in products.	Rich in phospholipids (Alhajj et al., 2020).	Allergen concerns (e.g., soy or egg lecithin) (Puglisi & Fernandez, 2022; Wang et al., 2023).
<b>Agar-Agar</b>	Low-fat confectionery, jellies, and desserts	Provides gelling properties and firm texture without adding significant calories (Pandya et al., 2022)	Overuse may result in overly firm or rubbery texture (Pandya et al., 2022).	Low in calories (Öztürk-Kerimoğlu, 2021).	May cause digestive discomfort when used in large amounts (Major et al., 2017).

# Biological Techniques

		Functional		Nutritional	
Solution type	Suitable food category	Benefits	Points of attention	Benefits	Points of attention
Enzyme-Catalyzed Modification	Oils, margarine, bakery products, dairy, snacks	Enzymes such as lipases can modify the structure of fats by breaking down tri-glycerides into free fatty acids and mono-glycerides, while retaining desired properties like texture and stability (Mao et al., 2024).	Potential cost implications and complexity in controlling the final product's properties	Reduce SFA (Mao et al., 2024).	Could affect digestibility, especially if free fatty acids are released (Hama et al., 2015).
	Dairy products, plant-based alternatives, oils, beverages	Certain microorganisms, including bacteria and fungi, can convert SFA into unsaturated fats (Adebo et al., 2022).	Potential variability in the final product and may require additional fermentation steps, which could increase production time and cost (Augustin et al., 2024).	Can increase levels of unsaturated fats like omega-3 fatty acids (Adebo et al., 2022).	Might lead to changes in taste and texture (Adebo et al., 2022).

## Biological Techniques (continued)

Solution type	Suitable food category	Functional		Nutritional	
		Benefits	Points of attention	Benefits	Points of attention
<b>Plant Breeding and Selection</b>	Oils (e.g., soybean, canola, sunflower), processed food products	Through traditional plant breeding techniques, crops can be developed that naturally produce oils with reduced levels of SFA (Qaim, 2020).	Potential challenges for scalability and timing (Qaim, 2020).	Oils with healthier unsaturated fats (Voedingscentrum, n.d.-f).	Limited control over the final fatty acid composition compared to other methods.

# 03 Ingredient Suppliers Saturated fat

## Functional Ingredient Suppliers

An extensive (not exhaustive) overview of ingredients and ingredient suppliers is available in the linked **Google Sheets database**.

Connect with ingredient suppliers within the [Healthier Food Community](#):

dsm-firmenich ●●●

**EVRI**  
INGREDIENTS

**MCLS EUROPE**  
A subsidiary of Mitsubishi Corporation Life Sciences Limited

**RUITENBERG**  
INNOVATION AS MAIN INGREDIENT

Are you missing any information, suppliers or ingredients?  
Please contact **[healthierfood@foodvalley.nl](mailto:healthierfood@foodvalley.nl)** and we can  
incorporate this in our next version.

# 04 Case Studies

## Saturated fat



# Fat reduction in crispy protein snacks



## What challenge was faced?

Crispy snacks like chips and protein crisps typically contain 10–30% fat. Salnova aimed to develop savoury snacks with significantly lower fat content, while maintaining indulgent taste and texture to offer a healthier, competitive alternative.

## How was the problem solved?

Instead of traditional oil coatings used to carry flavours, Salnova incorporated flavour precursors directly into the extrusion process. This method allowed flavour release during production, eliminating the need for post-processing oil application.

## Were there any obstacles?

Reducing fat content led to a drier, firmer texture. Salnova carefully balanced ingredients and fine-tuned extrusion settings to maintain a pleasant mouthfeel while achieving the desired flavour and fat reduction.

## What was the outcome?

Fat content was reduced to 3.4%, with no compromise in overall product quality, taste, or texture.

## Key takeaways and lessons learned

Understanding production processes is key to meaningful reformulation. While reducing fat, it's essential to anticipate and address textural trade-offs to maintain consumer appeal.

## For more details, contact:



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“Understanding production processes is key to meaningful reformulation. While reducing fat, it's essential to anticipate and address textural trade-offs to maintain consumer appeal.”

# A healthy low-fat ice cream: Soybean hull dietary fibre as a fat substitute



## What challenge was faced?

Fat reduction often leads to texture deterioration (e.g., reduced viscosity, poor shape retention, ice crystal coarsening, and gritty mouthfeel), posing key challenges to consumer acceptance, especially in ice cream.

## How was the problem solved?

Soybean hulls, rich in insoluble dietary fibre, possess oil-holding, water-binding, and gelling properties, making them a potential natural fat substitute. Additionally, soybean hull dietary fibre offers health benefits such as regulating gut microbiota, suppressing inflammation, and modulating immune responses.

## Were there any obstacles?

Green modification of non-dispersible dietary fibre extracted from soybean hulls to give it properties as a fat substitute, as well as determining the optimum percentage of dietary fibre to maximise the flavour and texture of the product.

## What was the outcome?

We found that the high viscosity and viscoelasticity of soybean hull dietary fibre added to ice cream mixtures improved the shape retention and melting characteristics of low-fat ice cream, as well as the creaminess, smoothness, stickiness and coldness of the ice cream.

## Key takeaways and lessons learned

There is a feasible application of dietary fibre obtained by extraction modification from soybean hulls, an agricultural by-product, as a fat substitute in low-fat ice cream. It improves shape retention, reduces ice crystals, slows melting, and improves sensory sensation in low-fat ice creams, as well as having the effect of improving intestinal health.

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“Green-processed soybean hull fiber, used as a fat substitute in low-fat ice cream, enhances texture, flavour, and melt resistance while supporting long-term health benefits.”

# An Innovative margarine substitute that reduces calories but maintains creaminess



## What challenge was faced?

The challenge was to develop a low-fat, low-calorie margarine alternative that keeps the familiar taste and texture while minimising calorie intake.

## How was the problem solved?

This product replaces traditional hydrogenated oils with a novel stabiliser system using whey protein microgels, creating a high internal phase emulsion (HIPPE) that mimics the texture and appearance of traditional cream.

## Were there any obstacles?

Determining the optimal whey protein microgels concentration that maximises delayed fat digestion while maintaining emulsion stability and the product's creamy texture and flavour.

## What was the outcome?

The product successfully delayed fat digestion by 20%-30%, maintaining the flavour and smooth spreadability of a traditional margarine. It achieved a low-fat, low-calorie profile while delivering the sensory experience consumers expect from high-fat products.

## Key takeaways and lessons learned

The novel low-calorie margarine substitute, leveraging pickering emulsion technology, effectively delays lipid digestion and reduces calorie intake, aligning with health-conscious dietary trends.

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“

An innovative, low-fat, low-calorie margarine alternative: perfectly aligned with today's health-conscious lifestyle trends.”





# Technical Knowledge & Support

## Consulting Firms

When reformulating a product, it is often unclear at the start which specific adjustments are needed that will lead to the desired outcome. Experts in product development each have their focus areas, often specialising in different macronutrients. However, these aspects are interconnected, and early consultation with the right specialists can significantly improve efficiency in both development time and costs. Seeking expert advice at an early stage helps streamline the reformulation process, ensuring that technical challenges are addressed effectively.

On the next page is a list of firms that provide expertise in product reformulation and can support various aspects of the development process.

Consulting firms **within** the Foodvalley network:



In-store market research on consumer behaviour.



Helps producers and private label manufacturers with market knowledge, sourcing, production and logistics.



Experts in food contract manufacturing.



Offers strategic support on sourcing, (new) product development, and business development for plant-based foods.



Food consultant for product development, manufacturing, and food science.



Purpose agency that helps leaders, brands and organisations apply more human sense to business



Private and independent contract research organization specialised in food and health innovation.



A digital platform for the measurement, evaluation and management of social, environmental and economic impacts.



Research and consulting partner through data and behavioural science.



Support food companies through partnerships and collaboration.



Support food companies with innovation and development challenges.



Consulting firms **within** the Foodvalley network (continued):



Research institute aiming to make knowledge applicable for companies.

Consulting firms **outside** the Foodvalley network:

**Food Bureau of Innovation**

Consultancy for food innovation and optimisation.

**KTBA**

Advisor in quality and business assurance

**TOP BV**

Technical development partner in practical innovation solutions for the food industry

Are you missing any consulting firms?  
Please contact **healthierfood@foodvalley.nl** and we can  
incorporate this in our next version.

# Innovation Facilities

Foodvalley supports leading food and agritech companies by leveraging their shared facilities and expertise and connecting them to new and innovative startups. This collaboration allows these companies to innovate and test new technologies in a cost-effective manner. Our support includes:

- **Innovation Collaboration:** By connecting established companies with startups, we foster a collaborative environment that drives technological advancement and keeps them ahead of the curve.
- **Access to Cutting-Edge Facilities:** We provide access to labs, field labs, and pilot plants to develop and test new solutions efficiently.

Check out Foodvalley's [Innovation Facility Database](#) and connect with peers and companies on the [Foodleap](#) platform. Access a unique database of research equipment and innovation facilities in agrifood, helping you accelerate innovation, maximise productivity, and collaborate with valuable partners. Whether you're looking for facilities to advance your research or aiming to share your capacity, Foodleap helps you find the right opportunities to grow and innovate.



Innovation facilities **within** the Foodvalley network:



Cosun innovation centre - Facilities to support innovation and open to collaboration.



Research institute for product development support.



Offer ReceptomiX technology, sensation-on-chip, for objective measurement of taste and health properties, and for profiling smells and volatile compounds.



Research institute in the agri-food sector from the Flamish government.



R&D centre focusing on food & health analytics, scientific consultancy and assisting in practical solutions.



Research facilities and equipment.



Ingredient marketplace for food manufacturers.

Innovation facilities **outside** the FoodValley network:

**Essensor**

Consumer research and sensory insights.

**Eurofins**

Analytical testing and product development support.

**Isi sensory futures**

Market research and sensory product research

**Normec Foodcare**

Sensory and consumer testing as well as R&D facilities.

**Nutricontrol**

Lab and R&D facilities for product testing.

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