FoodDrinkEurope

Technical Toolkit & Guidelines to Increase Whole Grains in Bread

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Contents

Executive Summary

This technical toolkit, developed by FoodDrinkEurope in collaboration with Fedima, provides practical guidance to support small- and medium-sized enterprises (SMEs) in increasing the whole grain content of bread products across Europe. It addresses the current lack of harmonised definitions and regulatory frameworks for whole grains at EU level.

Key findings and guidance:

- **Health benefits and consumption gaps:** Whole grains provide fibre, vitamins, minerals, antioxidants and other bioactive compounds, and are associated with reduced risks of cardiovascular disease, type 2 diabetes and colorectal cancer. Despite these benefits, whole grain intake across Europe remains below recommended levels, highlighting the need for increased availability and consumption of whole grain foods, particularly bread.
- **Role of bread in whole grain intake:** Bread is a staple food in Europe and represents a major contributor to grain intake. Increasing the whole grain content of bread products offers a significant opportunity to improve dietary fibre intake and overall diet quality among consumers.
- **Market and consumer trends:** Growing consumer awareness of health and nutrition is driving demand for whole grain products. This creates business opportunities for SMEs to reformulate and innovate bread products with higher whole grain content, supporting product differentiation and responding to evolving consumer preferences.
- **Production and technical challenges:** Transitioning from refined to whole grain ingredients presents technical challenges related to dough handling, processing conditions, texture, taste and shelf life. Whole grain flour doughs are typically less elastic, more water-absorbing and produce denser products. These challenges can be addressed through recipe adaptation, process optimisation, use of improvers, and adjustments to equipment and baking conditions.
- **Product development and labelling:** The toolkit outlines practical steps for analysing nutritional composition, calculating whole grain content and adapting recipes. It also highlights regulatory considerations, including the absence of harmonised EU rules for whole grain claims, while noting opportunities to communicate fibre content and nutritional value to consumers.

- **Implementation strategies:** SMEs are encouraged to adopt a gradual approach by partially replacing refined flour with whole grain flours thus progressively increasing whole grain content. Short-term actions include blending refined grain with whole grain flours and adapting existing recipes, while long-term strategies involve investment in product development, process optimisation and consumer acceptance of taste and texture changes.

This toolkit equips European bakeries with the technical knowledge and practical tools needed to increase whole grain content in bread, improve nutritional quality and contribute to healthier diets. By adopting incremental innovation and best practices, SMEs can successfully navigate technical challenges while meeting growing consumer demand for whole grain products.

1. Introduction

1.1 Background of the toolkit

Food and drink are essential to European culture and daily life, providing both nourishment and enjoyment. Dietary balance, which is providing the appropriate variety and quantities of food to support health and well-being, is an ongoing focus. The food and beverage business serves 1.5 billion meals every day across Europe, providing a chance to assist consumers in obtaining or maintaining balanced, healthy, and sustainable diets.

In its 2022 Action Plan for Sustainable and Resilient Food Systems, FoodDrinkEurope established "The Nutrition Action Project" to address nutrition-related concerns in the food and beverage industry. This workstream supports initiatives and collaborations that help food and beverage industries provide nutritious, safe, and tasty meals and drinks. One of the project's aims is to increase food's whole grain content.

1.2 Objective and scope

FoodDrinkEurope, in close collaboration with Fedima (Federation of European Manufacturers and Suppliers of Ingredients to the Bakery, Confectionery and Patisseries Industries) have developed this whole grain toolkit to assist small and medium-sized bakeries in incorporating more whole grains into their bread products.

The toolkit provides a practical guideline for small and medium-sized bakeries on how to use more whole grains in bread development, innovation and reformulation. It also provides background information on whole grain breads. This toolkit will be limited to bread, category 7.1 as described in the guidance document of Regulation (EC) No 1333/2008 on Food Additives, which provides details of the food categories in Part E of Annex II.

Details of the types of bread included for this toolkit can be found in Annex 1 of this document.

2. Basic information

2.1 Whole grain definition

What is whole grain?

At EU level, there is neither a definition for whole grain as an ingredient nor any harmonised EU law that regulates whole grain levels in foods. In addition, it is important to be aware that in different countries there might be different regulations regarding whole grain foods. This document refers to the definition of whole grains from the Definitions Working Group of the global Whole Grain Initiative[1]. It states: "*Whole grains shall consist of the intact, ground, cracked, flaked or otherwise processed kernel after the removal of inedible parts such as the hull and husk; all anatomical components, including the endosperm, germ, and bran must be present in the same relative proportions as in the intact kernel.*"

1 Kamp, J.-W. v., Miller Jones, J., Miller, K., Ross, A., Seal, C., Tan, B., & Beck, E. (2021). Consensus, Global Definitions of Whole Grain as a Food Ingredient and of Whole-Grain Foods Presented on Behalf of the Whole Grain Initiative. Nutrients, 14, 138

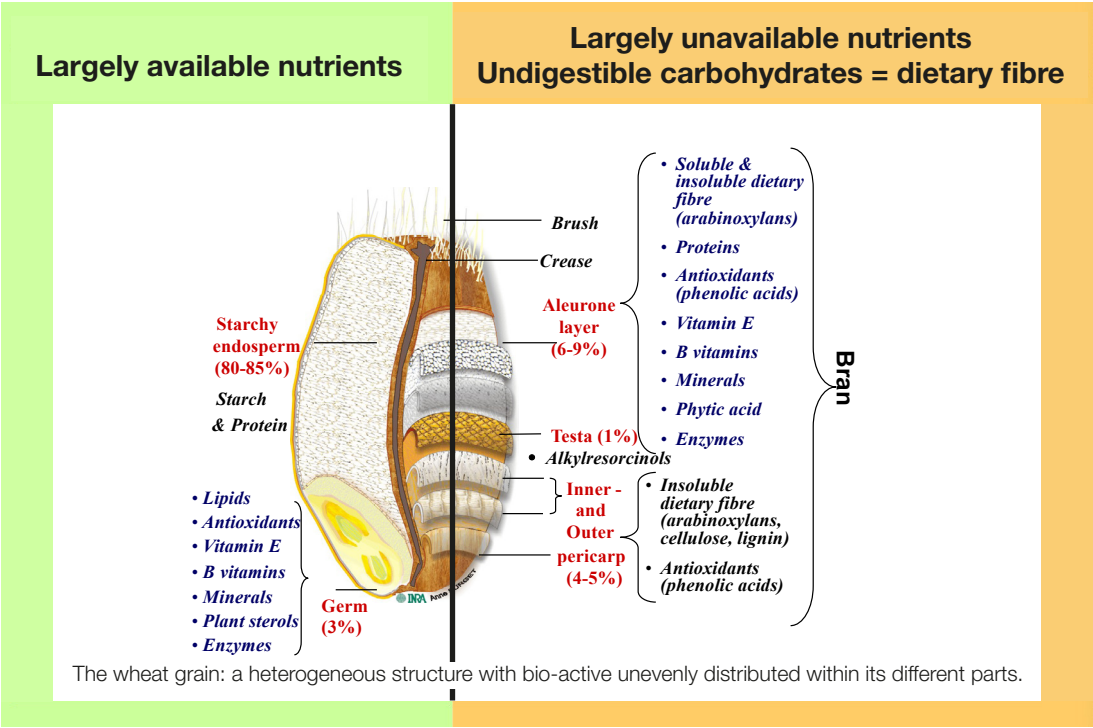

Figure 1. Anatomical structure of a whole wheat grain[2,3]

Benefits of whole grains

Whole grain consumption has been linked to improved health[4]. However, most Europeans do not eat enough whole grains[5]. According to recent analyses, switching to whole grains may be one of the most significant nutritional improvements. Whole grains provide fibre, protein, vitamins, minerals, antioxidants, and phytochemicals. Consuming them has consistently been associated with a lower risk of colorectal cancer, cardiovascular disease, and type 2 diabetes. Whole grain consumption has also been linked to a reduction in body weight, total cholesterol, and systolic blood pressure[6]. Higher whole grain foods contribute to higher dietary fibre intakes. This is important, because currently the majority of the consumers do no reach recommended dietary fibre intake levels, increasing whole grain bread can significantly contribute to these recommended intakes. The FoodDrinkEurope Guidelines: Whole Grains & Fibres - The Basics provide additional

2 Hemery, Y., Rouau, X., & Lullien-Pellerin, V. (2007). Dry processes to develop wheat fractions and products with enhanced nutritional quality. Journal of Cereal Science, 46(3), 327-347. https://doi.org/10.1016/j.jcs.2007.09.008

3 Surget, A., & Barron, C. (2005). Histologie du grain de blé (Histology of wheat grain). *Industrie des Céréales, 145*, 3-7

4 Reynolds, A., Mann, J. C., Winter, N., Mete, E., & Morenga, L. T. (2019). Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. *Lancet, 393*(10170), 434-445

5 Commission, E. (2017). Joint Research Centre - Health Promotion and Disease Prevention - Knowledge Gateway: Whole grain

6 Micha, R., Khatibzadeh, S., Shi, P., Andrews, K., Engell, R., & Mozaffarian, D. (2015). Global, regional and national consumption of major food groups in 1990 and 2010: a systematic analysis including 266 country-specific nutrition surveys worldwide. BMJ Open, 5(9), e008705

information on the health advantages of whole grains. Economic health modelling studies demonstrate that in Western populations (USA, Canada, Australia) a partial substitution of refined grains with whole grains can result in significantly lower healthcare costs for type 2 diabetes,[7,8] cardiovascular diseases7,[8,9] colorectal cancer[10] even with rather pessimistic scenario's when only 5% of refined grains is substituted with whole grains. Analysis of the National Diet and Nutrition Survey in the United Kingdom showed that higher whole grain intake was significantly associated with higher quality diets. This was reflected by higher consumption of dietary fibre, potassium, calcium, iron, magnesium, fruits/vegetables, pulses/nuts, and oily fish, and lower consumption of free sugars, total fat, saturated fat, sodium, and red/processed meat.[11]

2.2 Nutritional contribution of whole grains

Whole grain intake in Europe

Data on whole grain intake in Europe are limited. This is because whole grains do not have a consistent definition across the EU and lack research as a food group; many studies limit their scope to the intake of fibre. Table 1 provides whole grain intake numbers for some European countries and the United States.[12] It is important to note that whole grain intake values vary based on specific foods and methodologies used in studies. Therefore, the whole grain intake numbers are indicative and should not be compared between countries. Although the numbers are indicative, they clearly show that whole grain intake in many countries is below the recommended values, as a consequence, more whole grain bread can help to improve whole grain intake.

7 Abdullah, M.M.H., et al. Cost-of-illness analysis reveals potential healthcare savings with reductions in type 2 diabetes and cardiovascular disease following recommended intakes of dietary fiber in Canada. *Frontiers in Pharmacology* 2015; 6: 167. doi:10.3389/fphar.2015.00167

8 Abdullah, M.M.H., Huges, J., Grafenauer, S. Healthcare cost savings associated with increased whole grain consumption among Australian adults. *Nutrients* 2021; 13: 1855. doi.org/10.3390/nu13061855

9 Murphy, M.M., Schmier, J.K. Cardiovascular Healthcare Cost Savings Associated with Increased Whole Grains Consumption among Adults in the United States. *Nutrients* 2020; 12: 2323. doi:10.3390/nu12082323

10 Abdullah, M.M.H., Hughes, J., Grafenauer, S. Whole Grain Intakes Are Associated with Healthcare Cost Savings Following Reductions in Risk of Colorectal Cancer and Total Cancer Mortality in Australia: A Cost-of-Illness Model. *Nutrients* 2021; 13: 2982. doi.org/10.3390/nu13092982

11 Kutepova, I., Rehm, C., Joy Smith, S. (2025). Whole grain intake remains unchanged in the United Kingdom, 2008/2012 – 2026/2019. British Journal of Nutrition. DOI 10.1017/S0007114525104091

12 Seal, C. J., Nugent, A. P., Tee, E. S., & Thielecke, F. (2016). Whole-grain dietary recommendations: the need for a unified global approach. *British Journal of Nutrition, 115*(11), 2031-2038. https://doi.org/10.1017/s0007114516001161

Table 1: Whole grain intake in different populations[7]

(Medians and 5th, 95th percentiles; mean values with their standard errors)

Countries	Sex (n)	Age group (years)		Mean intake (g/d)		Median intake (g/d)		Source (year data collected)
		Median	5th, 95th percentile	Mean	SE	Median	5th, 95th percentile	
Norway 	F (1797)	48	42, 55	51	36	44	0, 120	[17](1995–2000)
Sweden 	F (1617)	50	40, 60	41	32	35	0, 120	
	M (1372)	60	40, 60	58	50	49	0, 149	
Denmark 	F (1994)	56	51, 64	37	32	31	0, 92	
	M (1922)	56	51, 64*	48	42	41	0, 116*	
France 	Both (1171)	3–17		4	0.3	0	20.5*	[18](2010)
	Both (1389)	>18		5	0.3	0	26.4*	
UK 	F (729)	1.5–17		15.3	15	11	4, 42	[19](2008–2011)
	M (773)	1.5–17		20.1	20.4	15	5, 29	
	F (880)	>18		23.6	22.8	19	6, 35	
	M (691)	>18		28.9	31.1	20	3, 42	
Germany 	F (275)	6–12		22	22.9	14.7	0, 57†	[20](1997–2008)
	M (280)	6–12		27	29.5	17.9	0, 66†	
	F (165)	13–18		24	28.7	16.3	0, 56†	
	M (170)	13–18		33	43.7	19.2	0, 84†	
Ireland 	Both (594)	5–12		18.5	18.2	12.7	68.5‡	[21]2003–2006)§
	Both (441)	13–17		23.2	29.5	13.4	97.9‡	
	Both (1051)	18–90		36.3	34.0	29.0	118.9‡	[22](2008–2010)
USA 	Both (3124)	2–18		16.2	0.57			[23](2009–2010)
	Both (5918)	≥19		23.2	0.85			

*Medians and 95th percentiles. † Medians and 10th, 90th percentiles. ‡ 50th and 97.5th percentiles.
§ 2003–2004 for age 5–12 years; 2005–2006 for age 13–17 years.

Recommendations for whole grain intake

The EU and various national dietary guidelines recommend increasing the consumption of whole grains. These recommendations typically fall into three categories:

- Non-specific: encourage eating more whole grains or choosing whole grain options
- Semi-quantitative: based on servings of cereal foods with whole grain proportions
- Specific: setting a target daily amount of whole grain intake

In most European countries, national dietary guidelines include a recommendation for whole grain intake.

Table 2: Summary of recommendations for whole grain intake in Europe

Country	Recommendation	Type of recommendation
Austria	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Belgium	Eat at least 125 grams of whole grain products per day.	Quantitative
Bulgaria	Prefer wholemeal bread and other whole grain products. Replace at least half of the white bread with wholemeal.	Qualitative
Croatia	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Cyprus	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Czechia	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Denmark	Eat at least 90 grams of whole grains per day.	Quantitative
Estonia	Eat at least 90 grams of whole grains per day.	Quantitative
Finland	Eat at least 90 grams of whole grains per day.	Quantitative

Country	Recommendation	Type of recommendation
France	At least one whole grain food per day.	Semi-quantitative
Germany	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Greece	It is recommended to consume 5–8 servings of a variety of cereals per day, with the largest quantity being whole grain.	Semi-quantitative
Hungary	Swap refined grains with whole grains and consume at least one serving of whole grain food as bread, pastry or side dish a day.	Qualitative
Ireland	Go for whole grain varieties wherever possible; choose whole grains at least twice a day	Semi-quantitative
Iceland	Eat at least 90 grams of whole grains per day.	Quantitative
Latvia	Eat at least 90 grams of whole grains per day.	Quantitative
Lithuania	Eat at least 90 grams of whole grains per day.	Quantitative
Luxembourg	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Malta	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Netherlands	Eat at least 90 grams of whole grains per day.	Quantitative
Norway	Eat at least 90 grams of whole grains per day.	Quantitative
Poland	Eat at least 3 servings of whole grain cereal products daily (90g/day).	Quantitative
Slovenia	Prefer, choose, favour, opt for, include or consume whole grain products	Qualitative
Spain	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
Sweden	Eat at least 90 grams of whole grains per day	Quantitative
Switzerland	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative
UK	Prefer, choose, favour, opt for, include or consume whole grain products.	Qualitative

While these recommendations are often linked to dietary fibre intake targets, the benefits of whole grains go beyond fibre alone, contributing to overall diet quality and health.[4]

Contribution of bread to whole grain intake

Indicative whole grain intakes are based on Global Dietary Database data[13]. (Total intake of whole grains includes breakfast cereals, bread, rice, pasta, biscuits, muffins, tortillas, pancakes etc. In this database a whole grain food is defined as a food with ≥1.0 g of fibre per 10 g of carbohydrate). This definition used by the EU is not in line with the definition as proposed by the Whole Grain Initiative.

Table 3 provides a global view on whole grain intake via bread in different countries in Europe. In this table information on bread and whole grain intake comes from different sources, but methodologies are different and therefore it is hard to compare between countries. Despite, the table provides an insight in which countries whole grain bread types are more often consumed compared to others as well as what part of the bread in a country is whole grain. It needs to be noted that whole grain is not an ingredient that is calculated in majority of food consumption surveys. Probably the closest marker of whole grain intake will be the amount of fibre provided by bread.

It can be concluded that, based on the estimated total whole grain intake in the different countries (table 1), the majority of whole grain intake comes from whole grain bread.

13 https://knowledge4policy.ec.europa.eu/health-promotion-knowledge-gateway/whole-grain_en

Table 3: Estimated whole grain bread intake in different EU countries[14]

Country	Whole grain bread intake (g/day adults)	Total bread consumption (g/day, adults)
Netherlands	67	130
Denmark	59	148
Sweden	44	87
Finland	43	87
Ireland	43	107
Belgium	39	104
Latvia	37	86
Hungary	31	138
Slovenia	29	103
Romania	26	137
UK	22	69
Bosnia and Herzegovina	22	114
Montenegro	20	117
Serbia	19	120
Italy	12	74

14 https://www.efsa.europa.eu/en/data-report/food-consumption-data - calculated with the most recent EFSA intake data of individual countries on whole grain bread intake

Country	Whole grain bread intake (g/day adults)	Total bread consumption (g/day, adults)
Greece	11	85
Cyprus	11	49
Poland	10	117
Croatia	10	81
Germany	8	123
Austria	8	80
Portugal	7	100
France	6	106
Spain	5	145
Estonia	2	42

2.3 Opportunities and challenges of whole grain flours / kernels

2.3.1 Whole grain bread success stories

Public-private partnerships have been successful in encouraging consumers to eat more whole grains through coordinated communication efforts.

Denmark: For example, the Danish Whole Grain Partnership, which brings together 27 partners from government, health organisations, industry, and retail, created a dedicated logo to designate whole grain foods. Since its launch, the number of products carrying the logo has grown from 190 in 2010 to 1,097 in 2019. The campaign has achieved wide recognition: 68% of Danes are familiar with the logo, and 80% of them say they use it go guide their food purchases. As

a result, the average whole grain intake in Denmark increased from 36g to 82g per 2400 kcal (10 MJ) by 2019. The Danish Whole Grain Partnership was appointed as a Best Practice example by EU in 2019 and by OECD in 2022.

Netherlands: In the Netherlands whole wheat is popular: In 2020, 2021 and 2022, whole wheat bread ranks as the most consumed type of bread (47%). As a strong product, whole wheat has the potential to both stimulate bread sales and boost the health of the Netherlands. That is why the Dutch Bakery Centre has set the goal within the current campaign 'Bread, good story' to increase this percentage to 56% by the end of 2023. At the end of 2025 it was increased to 57%.

Broodcampagne 2024 (Bread campaign 2024): A 360-degree media campaign with as goal to strongly promote whole grain bread to the Dutch consumer. It was done in week 4 and reached over 1 million consumers with positive messages on whole grain bread.

2.3.2 Business opportunities and impact

Consumer trends and business

Moving from more refined to more whole grain bread can offer significant business opportunities for SMEs due to increasing consumer demand for healthier and more balanced food and drink choices. There is rising health consciousness among consumers, who are actively looking for options with higher fibre, vitamins, and minerals, and specifically whole grains making whole grain bread more appealing.

Depending on the country there is more or sometimes less opportunity to move to more whole grain breads. This depends on the current level of whole grain bread consumption and acceptance by consumers of whole grain bread.

Although the trend is slow, it is expected that whole grain bread consumption will grow year on year compared to refined bread.

Production impact

Supply chain: Switching from refined to whole grain ingredients typically has minimal impact on the overall supply chain, as the primary difference lies in sourcing different raw materials. However, it also requires identifying reliable suppliers that meet quality and safety standards, while considering factors such as ingredient availability, consistency, and specific storage conditions.

Cost of production: Whole grain ingredients are typically slightly more expensive than refined grains. In the production of whole grain bread, generally more bread improvers are added to get more acceptable bread for consumers.

Impact on product characteristics

The number of whole grains in the bread will impact product characteristics. Increasing whole grain content in breads presents some technical challenges. These are outlined below, along with possible solutions to support smoother production:

- *Grain selection and processing equipment:* Whole grains vary in compositions (e.g., fat, fibre, and moisture levels), which can influence processing behaviour, texture, and shelf-life. These differences may require adjustments to mixing, to achieve the desired product quality
- *Moisture management:* Water absorption of whole grain is depending on the format (flour vs kibble etc). Adding whole grain ingredients to a recipe can affect how much water the dough absorbs
- *Taste and shelf-life:* Whole grains can have a slightly bitter flavour and a shorter shelf life than refined grains due to the potential for rancidity. Shelf life can be extended by preventing oil oxidation in the germ

2.3.3 Impact on production when changing from refined to whole grains[15,16]

There are a few things to think about when switching from refined flour to whole grain flour for making bread. To use whole grain flour, recipes need to be changed. When changing the recipes, there are a few things that need to be thought about. Because it has more fibre, whole grain flour absorbs more water. You might need to use different dough conditioners and/or additional vital wheat gluten.

Despite the use of dough improvers and vital gluten, the dough will be less elastic and less extensible with a reduced gas retention and denser structure due to the higher dietary fibre content of whole grain flours. In addition, the gluten structure, that is responsible for retaining the gas production from the yeast or sourdough, will be partly destroyed by the large particles of the dietary fibres in the whole grain flour. The dough will need shorter kneading time to improve the gluten development. Proofing time needs adaptation as well because fermentation in

15 Jacobs, P. Study on mechanisms governing the impact of wheat bran on bread making. Thesis nr 1931, Faculty Bio-engenering sciences, KU Leuven, Belgium, 2016

16 Hemdane, S. Probing and understanding the impact of wheat bran on straight dough bread making. Thesis nr 1938, Faculty Bio-engenering sciences, KU Leuven, Belgium, 2016

whole grain flour dough is generally faster when using the same amount of yeast in the dough due to the existing enzymes and nutrients in whole grain flour that are also used by the yeast.

One and another may also affect the necessary equipment. Mixers need to be able to handle a stickier and less elastic dough. Because of the fact that whole grain dough in general is stickier, it may be needed to use a non-stick surface or to add flour or oil when dividing the dough into required pieces. Proofing times, temperature and humidity may need adaptation and therefore the timing and moisture content in proofing cabinets need to be fine-tuned. Dividers may need adaptation for whole grain dough. In the stage of the moulding and panning, it is necessary to take care that the dough is less extensible and more fragile, especially when no dough conditioners and/or vital wheat gluten are added. Fine-tuning of conditions in the end stage of proofing / fermentation is essential to have an optimal result that can be baked off. Baking will take longer, amongst others due to the higher water content of the dough. A slightly lower oven temperature is often recognised. It is important to be aware that the loaf will have less oven spring than a white loaf. Steaming at the beginning of baking is essential for good oven spring and a crisp crust. Browning of the bread during baking will develop differently. As whole grain flour generates more dust and residues, equipment may require more frequent cleaning to prevent build-up of contamination. Table 4 summarises the potential adaptations in production and processing in the baking of higher whole grain bread.

Table 4: Potential adaptation in production and processes

Component	Change	Why
Mixer	May be	Stronger mixer may help improve hydration and dough development
Fermentation / proofing	Adjustment	Focus on timing, temperature and humidity
Dividing / moulding	May be	Dough is stickier and more fragile
Oven	Adjustment	Increase time and temperature and modify steam
Packaging	Adjustment	Change of bread size

A critical note needs to be made with respect to the size of the bakery. For the artisanal baker, the above indicated adaptation may not have a big impact on the total production process. In the small artisanal bakery, the necessary adaptation when switching from refined flour to whole grain flour can easily be done when

an automised production line is not installed. However, when a complete bread baking line is installed, this needs to be fine-tuned. Recipes, mixing and kneading time, proofing time, time spent in the oven including the temperature, must be fine-tuned for whole grain flour-based breads. When packing of the final product is automised as well, this part of the production line may also need adaptation. This will need specialised support from the ingredient and equipment suppliers.

2.3.4 Potential Impact on product characteristics

Whole grain bread is characterised by a much richer, nuttier and slightly sweeter flavour then refined grain breads, all due to the presence of bran and the germ. Many consumers experience more bitter and astringent notes in whole grain bread. The flavour moves from a simple, mild, neutral flavour in bread made with refined flour to a rich, nutty, earthy, and toasty flavour profile. The germ contains oils and sugars that can impart a slight, inherent sweetness. The aroma is much heartier, grainier, and more aromatic than the simple yeasty or bready smell of white bread. It often smells like toasted nuts and grains. The crust and crumb are darker due to the bran in whole grain flour and due to higher Maillard reaction potential. The structure of the crumb tends to be more dense and less airy because the bran interferes with the gluten development during the mixing process. This also may cause a gritty and fibrous texture, depending on the grit size. However, there are methods applying specific bread improvers to reduce the density of whole grain bread.

The use of whole grain flour challenges the baker to make tasty whole grain bread. Whole grain breads are less accepted by some consumers because of different taste and texture. However, we know that consumers can adapt and like the taste and texture of whole grain bread. Due to the higher fibre and lipid content, staling is considered slightly slower.

3. Toolkit to increase whole grains in your products

3.1 Current situation of available bread

3.1.1 Categories of bread in the European market

Bread in Europe is extremely varied, reflecting local baking methods, ingredients, and customs. Based on traits including leavening, flour type, form, crust, and cultural usage, European breads can be broadly divided into the following categories:

Category	Description and varieties
Leavened versus unleavened bread	• Most European breads are leavened with yeast or sourdough or a combination of both, giving the product a soft crumb and airy volume • Unleavened bread is found in some traditional and religious contexts
By leavening agent	• Sourdough; often related to natural or spontaneous fermentation which is usually based on lactic acid bacteria • Yeast, most often saccharomyces cerevisiae species • Combination of yeast and sourdough • Chemical leavening by baking soda/powder
By flour type	• Wheat based is the most common in southern and western Europe • Rye-based is rather common in northern and eastern Europe • Mixed grains, which are often blends of wheat, rye, oats and barley Nowadays, also ancient grains like spelt, amarant are used • Corn or chestnut flour; used in very specific regions (ie. Italy)
By crust and crumb	• Crusty breads; thick and crunchy crust • Soft-crust breads: thin or soft crust • Dense crumb: often rye and/or whole grain breads • Open crumb: light and airy, like ciabatta and focaccia
By shape and form	• Loaf shaped; standard rectangular tin-baked or pan-baked loafs, like British sandwich bread • Round or boule: traditional rustic forms • Flatbreads, like pita, lavas, focaccia • Braided breads like challah and zopf • Rolls and buns like Kaiser roll and milk buns

Category	Description and varieties
By regional/ national tradition	• French: Baguette, brioche, pain de campagne • German: Pumpernickel, Vollkornbrot, Brötchen • Italian: Ciabatta, focaccia, pane toscano, panettone • British/Irish: Bloomer, soda bread, baps • Scandinavian: Rye crispbread, tunnbröd, kavring • Eastern Europe: Borodinsky, kalach, obwarzanek • Balkan: Pita, somun, lepinja

3.1.2 Production methods per bread category

Numerous bread variants exist in Europe and worldwide. Basic ingredients include grain flour, water, yeast and/or another leavening agent, and salt. The mixing of these ingredients is the very first elementary step in the production process. The mixing process does not essentially differ between the bread categories available in Europe. Mixing is a part of the kneading process. The kneading process determines the rheological characteristics of the dough. In wheat-based doughs the development of the gluten network in the dough depends on the mechanical force during kneading. As indicated above, in doughs based on whole grain flours it is advised to add vital gluten to the ingredients to create a bread that is more airy and therefore more acceptable for most consumers. To allow a proper development of the gluten network in a dough based on whole grain flours, kneading time and or speed of kneading needs to be adapted.

Fermentation: time of proofing needs adaptation. Because whole grain flour is higher in enzymes and nutrient concentrations, yeast will grow faster in doughs based on whole grain flours then on refined flours. Shortening of proofing time is advised to prevent over-proofing.

Baking: Doughs that are based on whole grain flour contain more water due to the additional water absorption in the dietary fibres in whole grain flour. To create a final bread with a comparable water content as breads based on refined flours, baking time needs to be extended.

Crusting: Steam in the beginning of the bake gelatinises the outer layer of the dough, when the steam evaporates, the gelatinised layer bakes into a crispy crust. Steam in the first 10–20 minutes of your bake is needed (depending on the size of the loaf), followed by a dry heat for remainder of the bake.

3.2 Determining the opportunities

3.2.1 Analysis of the nutritional composition of your product

It is important to know the composition of your bread. Especially of the reformulated bread with increased whole grain content. For the higher whole grain bread, the nutritional composition will need to be calculated for labelling purposes and eventually analysed for nutritional and or health claims.

Analysing the nutritional composition of whole grain bread requires assessing its macronutrients (carbohydrates, proteins, and fats), micronutrients (vitamins and minerals), and dietary fibre content. All values should be reported on the nutrition label per 100 g.

Mandatory nutrition information for labelling

The nutrition declaration must include the following per 100 grams of the product:

- Energy value (in kilojoules (kj) and kilocalories(kcal))
- Fat (g)
- of which saturates (g)
- Carbohydrate (g)
- of which sugars (g)
- Protein (g)
- Salt (g)

To obtain a nutrition declaration, values may at minimum be based on calculations derived from supplier specifications. However, best practice is to conduct regular chemical analysis of the bread.

To have your products analysed, specialised companies like Eurofins, SGS, Intertek, can support product analysis. Most of these companies can also provide services on food safety and sensory analysis. A complete nutrient profile may

range between €500 and €2500 per sample. Such an analysis involves advanced methods and includes macronutrients and micronutrients analysis.

Due to the absence of an accepted, harmonised regulation at the EU level for whole grains, there are differences across Europe in what companies can communicate on whole grain content.

Currently, front-of-pack labelling does not permit whole grain-related health or nutrient content claims (e.g., “source of” or “high in”). However, it is possible to indicate the quantity of whole grain per serving or per 100 g of product on the label, provided it is based on dry weight.

However, whole grain foods have higher dietary fibre levels. Dietary fibre can be claimed front-of-pack with source of fibre if the bread contains 3g to 6g dietary fibre per 100-gram bread and with high fibre when the fibre content is higher than 6 g per 100-gram bread.

Calculating the whole grain amount of your product:

When increasing the whole grain content of a product, it is important to know the amount of whole grain that a finished product contains. The whole grain content is based on the product recipe. For example, if 50% of a bread recipe (by dry weight) consists of whole grains, then its whole grain content is 50%. A 30g slice (dry weight) of this bread would then provide 15g of whole grains.

3.2.2 Opportunities in adaption of your products

3.2.2.1 Fermentation technology

As in white bread production, fermentation technology is a strong technique in the manufacturing of bread, having several benefits such as higher nutritional value, greater digestibility, distinctive tastes, and extended shelf life. Fermentation is the use of micro-organisms (e.g., bacteria, yeast, or fungus) to break down carbohydrates, proteins, and lipids in whole grains, resulting in biochemical changes that improve the quality of the final product.

1. Improving nutritional value

Fermentation breaks down elements like phytic acid, which binds to minerals (iron, zinc, calcium) and changes absorption rate. This might impact the bioavailability of nutrients[17]. Fermenting microorganisms like lactic acid bacteria (LAB) can generate B vitamins (e.g., folate, riboflavin) and vitamin K, improving cereal nutrition. Fermentation can also create prebiotic substances (e.g., oligosaccharides) that aid gut health [18,19]. It is important to be aware that even scientific data indicate a relation between a nutrient or a product and health, a nutrition of health claim can only be made if approved by the European Commission. A full list of current allowed nutrition and health claims can be found on the website of the EU.

In Western countries, it is increasingly recommended to consume a diet rich in whole grains, legumes, vegetables, seeds and nuts, which seems controversial since most of these are relatively high in phytic acid. However, there is no doubt that this is associated with improved health outcomes]. The advice to avoid the consumption of whole grain foods because they contain phytic acid is unjustified[20].

2. Developing unique flavours

Fermentation produces organic acids (e.g., lactic acid, acetic acid) and aromatic compounds that contribute to the unique tangy, sour, or savoury flavours. Using specific cultures, fermentation can reduce the bitterness of certain whole grains.

3. Extending shelf life

Fermentation is a natural way of preservation. The organic acids and antimicrobial compounds produced during fermentation (e.g., lactic acid, bacteriocins) act as natural preservatives, inhibiting the growth of spoilage microorganisms and pathogens. The process can reduce the water activity in bread, further enhancing its shelf life.

17 Pujol, A., Sanchis, P., Grases, F., Masmiquel, L., 2023. Phytate Intake, Health and Disease: "Let Thy Food Be Thy Medicine and Medicine Be Thy Food". Antiox. 12(1), 146.; https://doi.org/10.3390/antiox12010146

18 De Bondt, Y et al. Wheat Sourdough breadmaking: A scoping review. Annu Rev Food Sc Technol 2024;15:265-282 doi: 10.1146/annurev-food-110923-03483

19 Adebo, J.A. et al. Fermentation of Cereals and Legumes: Impact on nutritional constituents and nutrient bioavailability. Fermentation 2022;8:63 https://doi.org/10.3390/fermentation8020063

20 Brouns, F. Phytic Acid and Whole Grains for Heatlh Controversy. Nutrients 2022;14:25. https://doi.org/10.3390/nu14010025

4. Functional health benefits

Depending on the used culture, fermentation can increase the levels of antioxidants in whole grains. Often fermented breads have a lower glycaemic index, which is positive, due to the breakdown of starches into slower-digesting carbohydrates. As these potential benefits are not conclusively proven, the use of health claims in the EU on these potential benefits are not permitted.

3.2.2.2 Enzyme technology in breads

Enzyme technology can be used to innovate bread production, improving nutrition, texture, and processing efficiency. Enzymes are proteins that catalyse certain biochemical reactions. Their capacity to modify components in a controlled and sustainable way has made them more useful in food preparation. Enzyme technology may boost breads' nutrition by enhancing digestibility, mineral bioavailability, and lowering anti-nutritional factors.

1. Improving nutritional value

Beta-Glucanase: Oats and barley contain beta-glucans, which are healthy fibres but can make the cereal too dense or gummy. Beta-glucanase enzymes partially break down these fibres, improving texture while retaining some of their health benefits.

2. Enhancing texture and mouthfeel

Amylase: Amylase enzymes break down starch into simpler sugars, which can change the taste and texture of the bread.

Maltogenic Amylases: These enzymes break down proteins in the grains, softening the texture. This is especially helpful for whole grains like wheat or barley, which can be tough.

Xylanase: Xylanase enzymes break down hemicellulose, a component of the grain's cell wall, improving the dough's elasticity and the final product's texture.

3. Optimising processing efficiency

Cellulase: Breaks down cellulose in the grain's outer layers, improving the efficiency of milling and reducing processing time.[21]

21 Kumar, A et al. Role of cellulases in food, feed and beverage industries: Enzymes in industrial food processing. In book: Green bio-processes, Springer Nature, 2019. Chapter 17, pp 323-343. Doi:10.1007/978-981-13-3263-0_17.

4. Enhancing flavour

Proteases: These enzymes produce maltose and other sugars during processing, enhancing the natural sweetness and flavour.

Phospholipases: Lipase enzymes break down fats into free fatty acids, which can contribute to the development of desirable flavours during toasting or baking.

3.2.2.3 Addition of nutrients/bio-active substances

Fortification is the practice of adding vital and bioactive ingredients to a product therefore increasing their nutritional benefits. Beyond simple nutrition, this strategy offers functional health advantages and helps correct dietary deficits. Whole grains are naturally high in fibre and higher in minerals than non-whole grains, and fortification can supplement key nutrients such as iron, vitamin D, and B vitamins. Some nutrients found in whole grains are bound by antinutrients (such as phytic acid), making absorption difficult. Fortification helps to overcome this constraint. Key essential nutrients used in fortification are iron, calcium, vitamin D, B-vitamins (B1, B2, B3, B6, B12, folic acid) and zinc. Furthermore, dietary fibre and prebiotics, such as beta-glucans, inulin, fructo-oligosaccharides and resistant starch can increase the already high level of dietary fibre content. Probiotics, omega-3 fatty acids, polyphenols and carotenoids are also frequently used for fortification.

Methods used to fortify are dry blending, encapsulation, extrusion cooking and spray coating. Fortification needs extra attention for stability of the added nutrients. Some fortified nutrients can alter the sensory properties. Certain compounds (e.g., iron salts) need careful selection to ensure absorption without affecting taste. Nutrient levels must meet levels set by food regulations.

3.3 Building a plan to change to more whole grains in bread

3.3.1 Know your market

Before innovating bread with more whole grains, it is essential to understand the market(s) you want to be active in. This includes analysing/understanding consumer preferences, market trends, competition, and economic conditions.

A first step for deciding to start with the production of higher whole grain bread is examination and understanding of the local market. Estimate, where possible, the size of the whole grain bread market in terms of revenue, volume, and

growth rate. It is important to be aware of and understand key consumer trends (e.g., whole grain, low-sugar, high-protein, low sodium, health benefits, organic, convenience). Based on this information, it will be possible to make a decision on which and how much whole grain bread can be sold.

3.3.2 Determination of investment needs

When changing from refined to whole grain bread, some level of investment may be needed. Start with conducting a cost analysis to understand the financial impact of the transition and set appropriate pricing for the new products.

Whole grains (e.g., whole wheat, rye) may be more expensive than refined grains. They may also require different storage conditions to maintain freshness and prevent spoilage.

It may be necessary to adjust logistics and distribution plans to accommodate any changes in production schedules, storage requirements and shelf-life considerations. Existing production lines may need to be retrofitted or upgraded to handle the different physical properties of whole grains. The whole grain ingredients can lead to increased wear and tear of machinery and may require a different and potentially more intensive cleaning process.

3.3.3 Short term opportunities

Transitioning from refined to whole grain breakfast bread can be relatively straightforward. Start with introducing partly whole grain breads. These changes typically require minimal adjustments to existing production lines.

A complete switch from refined flour to entirely whole grain is not immediately necessary. Instead, take small steps by blending whole grains with refined in existing recipes. For example, mix whole wheat flour with refined flour or add whole oats to the cereal base. This approach requires only minor adjustments to equipment or processes while gradually introducing whole grains to consumers.

3.3.4 Planning long term product development

For a successful change from refined to whole grain breads, a gradual substitution of refined to whole grains is suggested. This involves a stepwise change in the mix of refined versus whole grains, allowing consumers time to adapt to changes in taste and texture. For small artisanal bakeries, the necessary adaptation when switching from refined to whole grain flour can easily be done in the

case an automised production line is not installed. However, when a complete bread baking line is installed, this needs to be fine-tuned, and support from the supplier of the equipment is needed. Also, choose which bread type is the most practical to produce more whole grain. Once consumers have become accustomed to and have developed a liking for bread with higher whole grain content, further increases to the whole grain content in the recipe may be considered.

A practical starting point is to develop a range of whole grain type breads using existing equipment. Over the long term, if the goal is to innovate and develop different types of whole grain breads, investment in high-quality equipment and ingredients (e.g., whole wheat, oats, quinoa, etc.) may be required.

Product developers could focus on refining formulations to achieve the right balance of taste, texture, and nutritional value. It is important to incorporate ingredients that align with consumer trends. Regularly gathering feedback can help to improve the product into the right direction, while staying Up to date on industry developments could help support timely adjustments to the production process accordingly.

Annex 1. Products that are included in the Whole Grain Toolkit and products that are NOT included in the Toolkit

Products which are prepared mainly with cereal flour or cereals and may have undergone a treatment, e.g. baking, steaming, extrusion. Includes categories for bread including:	
Included bakery wares	
Bread and rolls	Bread prepared solely with the following ingredients: wheat flour, water, yeast or leaven, salt, like e.g. wheat bread, rye bread, whole grain bread, multi grain bread, malt bread, pumpernickel bread, rolls (hamburger rolls, whole wheat rolls, milk rolls), bagels, pita bread, Mexican tortillas and steamed breads. This category includes bread-based products, e.g. croutons, bread stuffing, prepared dough.
Pain courant français	Bread prepared essentially with the following ingredients: breadmaking flours (wheat flour, rye flour, meslin flour), water, yeast and/or leaven, salt. Other food ingredients can be added for a technological purpose in accordance with the national general principles.
Fehér kenyerek	White bread, consisting of 100% of wheat-flour, produced with yeast or yeast substitute, manufactured through kneading, forming, rising and baking of the dough.
Félbarna kenyerek	Semi-white bread, consisting of 85% semi-white wheat-flour and 15% light rye-flour, produced with yeast or yeast substitute, manufactured through kneading, forming, rising and baking of the dough.
NOT included bakery wares	
Fine bakery wares	Sweet, salty and savoury products such as cookies, cakes, muffins, doughnuts, biscuits, macarons (i.e. round products made typically with almonds, icing/powdered sugar and egg whites), rusks, cereal bars, pastries, pies, scones, cornets, wafers, crumpets, pancakes, gingerbread, éclairs, croissants, as well as unsweetened products such as crackers, crisp breads and bread substitutes, including prepared doughs* [or mixes for their preparation*]. It also includes sponge cakes, essoblaten and wafer paper and edible paper ('edible paper' does not refer to a paper but to a food placed on the market under the name 'edible paper' usually consisting of dried starch sheets or made of rice or potato starch of various thickness or texture and consumed as such). In this category a cracker is a dry biscuit (baked product based on cereal flour), e.g. soda crackers, rye crisps, matzo.
	(excluding pre-dusts, and doughs which are covered by category 6.6).

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