



Reducing bread surplus and waste at the bakery-retail interface in three European countries

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ABSTRACT

Bread is one of the major contributors to food waste in many countries. This study focuses on the bread value chain, particularly the relationship between bakeries and retailers, to provide insights on practices contributing to bread surplus and waste, alongside solutions for how these could be avoided. The study utilises qualitative data collected through bread value chain stakeholder dialogues organised in Finland, Italy, and Sweden. The study identifies six key issues pertinent at the bakery-retail interface that contribute to the emergence of bread surplus and waste and discusses potential solutions: daily surplus and waste measurement, product assortment management, ordering schedules and terms, knowledge and data sharing, consumer education, and surplus bread management. The study contributes to literature on bread waste management and has managerial implications for bakeries and retailers.

1. Introduction

Despite growing attention from politicians, researchers, and practitioners, food waste—edible food that is produced but not consumed—remains a critical sustainability issue worldwide. Recent estimates indicate that 1.05 billion tonnes of food are wasted annually across the globe (Forbes et al., 2024). In the European Union (EU), the average food waste per capita in 2024 was 131 kilos, with households accounting for 54 % and the remaining 46 % occurring higher up the food supply chain (Eurostat, 2024). These figures highlight the urgent need for efficient solutions targeting the entire supply chain in reducing the harmful environmental and social impacts of food waste.

Previous research on food waste has primarily focused on individual actors in the supply chain, such as households, retailers, or restaurants. The relationship between retailers and food suppliers has been identified as a critical hotspot for food waste generation (de Moraes et al., 2020, 2022; Devin and Richards, 2018; Ghosh and Eriksson, 2019; Mena et al., 2011), yet studies addressing solutions at this supplier-retail interface

remain limited (Mena et al., 2011; de Moraes et al., 2020; Winkler et al., 2023; Yang et al., 2023). One reason for this gap may be that it is easier to concentrate on internal, controllable causes of food waste. Another factor could be the market power retailers often yield over suppliers (Eriksson et al., 2017; Ghosh and Eriksson, 2019; Devin and Richards, 2018), potentially reducing retailers' incentives to minimize surplus and waste.

One critical product in retailer-supplier dynamics is bread, one of the staple food in diets globally, which is not only frequently discarded in households (Ananda et al., 2024) but also contributes significantly to surplus and waste in retail and bakery sectors (e.g., Bartek et al., 2025; Brancoli et al., 2019; Hanssen and Möller, 2013; Katajajuuri et al., 2014; Lebersorger and Schneider, 2014; Pietrangeli et al., 2023). Previous studies on supplier-retailer relations have primarily concentrated on the supply chain of fruit and vegetables (e.g., de Moraes et al., 2022; Devin & Richards, 2018). Research specific to bread surplus and waste in the European context (see Pietrangeli et al., 2023 for a review) suggests that take-back agreements (TBAs) between bakeries and retailers obscure

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bread surplus and waste from quantification in retail settings. For instance, Eriksson et al. (2012) and Scholz et al. (2015) excluded bread waste from their assessments because it was typically managed by suppliers, while store-level data remained unavailable. Similarly, Cica-tiello et al. (2017) found in an Italian supermarket study that although bakery waste accounted for 30 % of total food waste by mass, most bread waste went unrecorded, amounting to less than 1 % in store databases.

To extend the literature on bread waste, this study adopts a solution-oriented approach to investigate the current practices contributing to bread surplus and waste at the bakery-retail interface in three European countries. In the European Union's legislative framework, food waste is defined to consist of "parts of food intended to be ingested (edible food) and parts of food not intended to be ingested (inedible food)" (Eurostat, 2024). To follow the EU definition on food waste, bread waste here refers to any waste occurring during the production process in the bakeries (this might include also inedible parts, such as bread not yet baked or overbaked) as well as bread discarded as waste during the final consumption stage. However, as our focus in this paper is at the bakery-retail interface, i.e., the consumption stage, waste here concerns mostly edible food. With bread surplus, on the other hand, we refer to any bread that is baked or retailed, but which is not sold to or consumed by the intended customer (Garrone et al., 2014), not necessarily becoming bread waste if repurposed (Pietrangeli et al., 2023).

While several studies have examined the causes of food waste, only a few have explicitly linked these causes to targeted solutions (Mena et al., 2011; de Moraes et al., 2020). Previous research also underscores that addressing food waste requires coordinated efforts between different actors along the supply chain (Liljestrand, 2017; N  rv  nen et al., 2020). Despite the similarities between food supply chains that handle fresh items, notable differences in practices—particularly in the bakery sector—highlight the need for a more focused analysis on bread. Earlier studies conducted in Sweden, for example, have noted that ordering practices between bakeries and retailers significantly contribute to bread surplus and waste, and similar practices are not as prevalent in other food categories like fruits, vegetables, or dairy products (Eriksson et al., 2017). This is, according to Eriksson et al. (2017), Ghosh and Eriksson (2019) and Brancoli et al. (2019), because the handling of unsold bread is taken care of the bakery rather than the retailer, thus giving the retailer both limited power and incentive to reduce bread waste. In Sweden, the practice of these take-back agreements is very uncommon for other types of food products at retail level. Furthermore, country-specific differences in how supply chains of bread operate have not been examined. These suggest that a holistic examination of bakery-retail interface is necessary, extending beyond the typical focus on contractual agreements.

The empirical study draws on qualitative data gathered from stakeholder dialogues – workshops and interviews with retailers and bakeries – where current practices contributing to bread surplus and waste, as well as potential solutions, were discussed. Data generation took place across three European countries: Finland, Italy, and Sweden. These countries were chosen due to their unique market characteristics, which offer valuable comparative insights into the challenges and opportunities for reducing bread surplus and waste.

2. Empirical research

2.1. Method

This study adopted a qualitative approach to investigate current practices contributing to the emergence of bread surplus and waste at the bakery-retail interface and to explore potential solutions. Qualitative methods were chosen because they allow for an in-depth understanding of complex, context-specific interactions between retailers and bakeries, which are not easily captured through quantitative measures. The study utilised a method of stakeholder dialogues which has been suggested as a way to assess complex problems and to generate and evaluate different

viewpoints (Cuppen et al., 2010). A stakeholder dialogue refers to "an organized meeting of stakeholders with different perspectives, knowledge and backgrounds, who would otherwise not meet" and where "stakeholders deliberate on a specific issue in order to produce new insights" (Cuppen et al., 2010, p. 580).

The stakeholder dialogues were organised in a slightly different manner in Finland, Italy, and Sweden (see Table 1) to accommodate market-specific characteristics. In Italy, the stakeholder dialogues involved only bakeries, whereas in Finland and Sweden, also retailers and other stakeholders were included. In all three countries, the stakeholder dialogue discussions were facilitated by researchers. The researchers organising the discussions were either already experts in studying the bread waste or food waste in general. Furthermore, they gained background knowledge from additional interviews with relevant organisations. For example, in Finland, the researchers first interviewed a representative of the Finnish Bakery Federation and in Italy, a local organisation representing the bakeries was involved in the project. A more detailed description of the stakeholder dialogue protocol has been published earlier as a public project deliverable of the LOWINFOOD project (Sj  lund et al., 2022).

The stakeholder dialogue approach enabled generating rich and detailed data on the perspectives, experiences, and practices of relevant

Table 1
Summary of the stakeholder dialogue data.

Stakeholder dialogue	Finland	Italy	Sweden
Data collection	- four online workshops (each lasting about 90 min) with 2–4 bakeries and a representative of the Finnish Bakery Federation - 10 one-to-one interviews with bakeries and retailers	- Three face-to-face discussion roundtables (each lasting about 90 min) with 12 small bakeries from North Lazio Region	- Three rounds of one-to-one conversations conducted online with bakeries, retailers and one logistics partner (7–9 companies)
Period	January 2022 – September 2022	November 2021 – May 2022	November 2021 – September 2022
Topics for discussion			
1st round	- Introduction to the project - Perceptions on bread waste - Current actions taken, including monitoring and measuring	- Introduction to the project - Discussion on the type of market and bakeries' role in the supply chain - Exploring solutions to avoid bread waste and surplus - How to quantify the surplus	- Introduction to the project - Views on issues related to bread waste - Ideas for solutions
2nd round	- The journey of bread: why bread waste occurs and what can be done to prevent it?	- Feedback on the first months of measurement and data recording - Any issues raised during the measurement	- Identifying common or contradictory viewpoints on how bread waste could be reduced - Identification of possible barriers
3rd round	- Solutions for zero bread waste in the bread supply chain	- Feedback on the initial roadmap developed by the researchers (facilitators)	- Feedback on the initial roadmap developed by the researchers (facilitators)
4th round	- Feedback on the initial roadmap developed by the researchers (facilitators)		

bread supply chain actors in the three countries. These insights were critical for identifying not only the drivers of bread surplus and waste but also solutions that could be implemented in diverse market contexts. First, in each country, country-specific roadmaps were created to address the identified challenges and to propose practical solutions to key stakeholders in each country. The roadmaps were developed together with the stakeholders, providing the participants an opportunity to co-design the roadmap actions with the researchers as well as to comment on the draft versions of the country-specific roadmaps. The roadmaps have been published as a public deliverable in the LOW-INFOOD project (Mesiranta et al., 2023) and were intended to give practical suggestions for the relevant stakeholders of the bread supply chain in each country. Second, the authors jointly looked for common themes in the country-specific roadmap solutions that would enable making comparisons between the countries and focusing on the bakery-retailer interface. As a result, six key issues relevant to the bakery-retailer interface were identified. To contextualize the results, short descriptions of bread markets will be presented in the next section.

2.2. Research contexts: bread markets in Finland, Italy, and Sweden

In Finland, the bakery sector is the largest sub-field of the food industry, with over 600 bakeries, ranging from large industrial firms to small local operators (Hyrylä, 2021). The market is dominated by two major bakeries, which hold over 50 % of the market share (Tammilehto, 2019), fostering intense competition. Many bakeries are traditional, family-owned businesses, some dating back to the 1850s. Fresh bread accounts for over 90 % of bakery sales, with most of it sold pre-packaged through retailers (Hyrylä, 2021; Tammilehto, 2019). The food retail sector in Finland is highly concentrated, with the top two retailers controlling over 82 % of the market in 2021 (NielsenIQ, 2022). Given this concentration, bakeries largely rely on these retailers for distribution, making them also pivotal players in managing bread surplus and waste. Typically, ownership of bread shifts from the bakery to the retailer upon sale, and retailers are responsible for handling any surplus, often donating unsold bread. In 2019, fresh bread and bakery items were the leading contributors to food waste among retailers, representing around 5 % of total sales volume (Riipi et al., 2021).

In Sweden, the bread supply chain is dominated by three industry bakeries that together hold over 80 % of the market share for soft, pre-packaged, savoury bread, while private label bread produced by retailers only hold 16 % of the market. One of the major differences between the industrially produced bread and private label is that the former is normally sold and distributed under a take-back-agreement. Ultimately, this agreement holds the bakeries responsible for the full management of their bread, including unsold products at retail. Although sold at retail, retailers themselves currently have limited power to reduce the surplus of pre-packaged bread sold under TBAs, and most bread waste is directed towards either anaerobic digestion or incineration (Bartek et al., 2025).

On the other hand, in Italy, the bread supply chain is mainly composed of small-scale bakeries that directly sell their products in their own stores, or supply retailers. Fresh bread is handmade daily during the night. There are over 20,000 artisan bakeries operating throughout Italy, producing around 1.5 million tonnes of bread each year (SIGEP, 2024). They typically are small family businesses (maximum 10 employees), and they represent the core business of this sector, as they produce 84.1 % of bakery bread sold in Italy (Associazione Italiana Bakery Ingredients, 2022).

3. Results and discussion

In this section, we present the results from our analysis, identifying six key issues pertinent to the bakery-retail interface in addressing bread surplus and waste: *Daily surplus and waste measurement*; *Product assortment management*; *Ordering schedules and terms*; *Knowledge and data*

sharing; *Consumer education*; and *Surplus bread management*. Although these issues are broadly similar, they manifest differently in each country, reflecting the specific market characteristics and dynamics between the value chain actors.

3.1. Daily surplus and waste measurement

The inconsistent use or, in some cases, complete lack of methods for tracking bread surplus and waste can obscure the scale of the problem for those involved in the bakery-retail interface. Without standardized tracking systems, it becomes difficult to identify the extent of surplus, estimate production or demand, or to implement effective waste reduction strategies. In our data, this issue was highlighted especially in Italy, where it was evident that the bakeries involved in the study had not measured their daily surplus, even claiming that they did not produce any waste (see also Pietrangeli et al., 2023). One possible explanation for this phenomenon is the smaller operational scale of Italian bakeries compared to those in other countries. In Italy, bakeries often cater to a highly loyal customer base, which facilitates the estimation of daily production needs. Given their direct relationship with consumers, Italian bakeries rely on their experience and established customer patterns to determine production volumes. This familiarity with customer demand fosters a strong confidence among Italian bakeries in their ability to optimize production and minimize waste. Consequently, they may perceive formal tracking methods as unnecessary, relying instead on their implicit knowledge and experience. As part of activities of the stakeholder dialogue, the bakeries involved were asked to record, on a daily basis, the overall volume of bread production for 5 months, along with the amount of surplus bread and its destination. The results of this effort are described in detail in Pietrangeli et al. (2023), showing that a rate of surplus bread around 5 % of the production, with small variations depending on the type of bread. Considering the low overall volume of bread production (typically, less than 250 kg per day), the issue of bread waste seems not very relevant for them, because it corresponds to few kilograms of surplus bread every day. However, the absence of systematic measurement limits the potential for identifying inefficiencies and implementing structured waste reduction strategies.

In Finland, the large industrial bakeries have systematic measurement systems in place, and also some middle-sized bakeries have made initiatives to track surplus and waste. However, especially the smaller bakeries in Finland still had not yet adopted measurement of their surplus or waste. The most developed country in this issue is Sweden, where the three large industrial bakeries have systematic tracking of the surplus and waste. However, in Sweden the wide adoption of TBAs at the bakery-retailer interface means that as the bakeries operate the coordination of their unsold bread at the retailers, bread surplus remains unnoticed in studies on waste quantification in retail settings. Although both the industrial bakeries and retailers claim to measure how much is produced, sold, and returned, this data is generally not shared between actors operating the supplier-retailer interface, neither with external partners, as it is considered confidential. This in turn limits the transparency of how much waste is produced and how it is managed.

As highlighted in this analysis, the lack of systematic daily surplus and waste measurement is primarily an issue affecting small-scale bakeries, whereas larger organizations tend to rely on more structured quantification systems. For these larger companies, measuring surplus and waste is an integral part of their business operations, allowing them to maintain a balance between production and unavoidable waste. This results in a predictable level of surplus, which is already factored into their operational planning. On the other hand, small scale businesses operate under greater financial constraints and prioritise maximising their revenue by ensuring that all production is sold. In cases of surplus, they are more inclined to seek alternative solutions, such as reuse or redistribution, rather than allowing their production efforts to go to waste. The small dimension of their business also allows them to be more flexible in allocating surplus bread on other channels.

3.2. Product assortment management

The large product assortment offered by bakeries and retailers introduces significant risks of bread surplus and waste. A wide range of products can make it challenging for bakeries and retailers to accurately predict consumer demand, often leading to overproduction and unsold goods. This variety, while aimed at satisfying diverse customer preferences, can unintentionally contribute to higher levels of waste for both actors in the bakery-retail interface. The wide product assortment is particularly problematic in Finland and Sweden, because bread is sold mainly through large retailers that want to accommodate various consumer requests for different types of bread. Also, the competition between bakeries for shelf space is intense. To secure shelf space for their products and thus, market share, bakeries need to have products in many categories so that they would be well represented in the store. Consequently, many bakeries deliver local products nationwide, leading to extensive bread assortments even in the smallest stores. Bakeries also need to constantly innovate new products alongside their existing ones, which easily results in an even wider product assortment. It is also common that popular bread types are produced by several different companies and delivered nationwide, creating an assortment where the same type of bread can be sold under 4–5 different labels and brands in each supermarket.

To address this issue, bakeries, particularly smaller ones, could assess their product offerings to identify opportunities for streamlining assortment and focus on their best-selling products. Collaboration with local retailers to understand product strengths and customer preferences could help in doing so. Retailers could also review their product ranges, using customer data, waste metrics, and local preferences to optimise assortment. Store managers are identified as key players in this evaluation and decision-making process.

3.3. Ordering schedules and terms

The imbalance between ordering and production schedules often leads to inefficiencies in bread production at bakeries. This is because the production of bread takes time, and the amount of demand should be known before the production starts. When production does not align with actual demand, bakeries may produce too little, causing stock shortages, or too much, leading to surplus and waste. This misalignment can be particularly problematic for bakeries trying to manage large product assortments or fluctuating consumer preferences.

In Finland, retailers typically place orders one or two days before the delivery. However, bakeries must begin preparing dough before orders are received, relying on their own demand forecasts. To address this, retailers in Finland should place orders earlier. Also, a digital platform could be developed to manage surplus bread more efficiently, allowing bakeries to offer excess stock to retailers systematically. In Sweden, the producers (especially for bread sold and distributed under TBAs) are responsible for placing the orders based on their own forecasts, sometimes without any actual insight into the point-of-sales data collected at retail. By sharing data between the bakeries and retailers in Sweden, better forecasting would be enabled which in turn could result in less surplus when production can be adjusted according to consumption.

Also, the purchase terms between retailers and bakeries have an effect on bread surplus. In Sweden, large scale bakeries normally use a business model including TBAs that are applied between bakeries and retailers. The TBA infers a reversed logistics to the bread value chain, which is logical in terms of efficient source separated waste management, but it restricts the incentives and possibilities for retailers to take waste reducing actions. With the TBA in place, supermarkets do not own the bread. Bakeries are responsible for placing the bread in the shelves and removing the unsold (surplus) bread. This limits the possibility for the retailers to take any actions reducing the waste through lowering the price or donating to charity. This compares to Finland where retailers cannot return unsold bread without paying for them unless a “bread

waste guarantee” agreement is in place, where retailers only pay bakeries for sold items. This arrangement helps bakeries secure better shelf space but may reduce incentives for retailers to prevent surplus. Recent updates to Finland’s Food Market Act in May 2023 now limit these agreements to new products and for no more than three months, encouraging better demand forecasting. Even if Artificial Intelligence – driven forecasting systems will not solve the problems of having distributed responsibility and adequate data sharing, they can probably also be used to facilitate matching production with demand.

In Italy, small bakeries tend to produce slightly more than the expected demand to accommodate last-minute orders and prevent stock shortages, which could lead to customer dissatisfaction (see also [Riesenegger et al., 2023](#)). However, this practice may result in significant bread surplus if overproduction is not sold or repurposed effectively. A potential solution to mitigate this issue involves educating consumers on the importance of placing advance orders, particularly in cases of anticipated high-volume demand. This approach is especially beneficial for small-scale bakeries, which often face difficulties in handling unexpected surges in demand due to their limited production capacity. Given their high level of customer loyalty, small bakeries could leverage direct communication channels to encourage pre-ordering and optimise production planning.

3.4. Knowledge and data sharing

Retailers and bakeries possess complementary knowledge—bakeries have expertise in specific demand forecasting (e.g., how weather affects the demand of bread), while retailers have broader customer data (e.g., loyalty card data)—but this is not fully leveraged. In Finland and Sweden, the intense competition in the bread and retail markets makes actors hesitant to share information with one another. This reluctance stems from concerns that revealing production data, sales forecasts, or supply chain details might provide competitors with an advantage, potentially leading to lost market share or diminished profits. Thus, collaboration between bakeries and retailers often suffers, limiting opportunities for efficient coordination in areas like demand forecasting or surplus management.

In Finland, this issue is partly addressed by meetings between bakeries and retailers. These meetings focus on sales, but data sharing depends on the retailer and the size of the bakery, with larger bakeries receiving more information. Consequently, bread surplus and waste reduction should become a key agenda in these meetings, encouraging also more systematic tracking, particularly for smaller bakeries, which often lack such practices. Altogether, in Finland and Sweden, effective information sharing and joint decision-making between bakeries and retailers is crucial for reducing bread surplus and waste.

3.5. Consumer education

As bread waste is not only a problem of the supply side, involving consumers in the effort to reduce it would be beneficial. Italian bread consumers are characterised by a good knowledge of quality attributes of bread, and well-defined preferences for attributes related to origin and typical features of bread ([De Boni et al., 2019](#)). This is also reflected in the relationship between bakeries and their customers is often characterised by familiarity and routine interactions. This is evident both in rural areas, where the local bakery serves as a community hub, and in larger cities, where neighbourhood bakeries often function as informal meeting points, especially for elderly people. In both cases, consumer education is facilitated by the high level of customer loyalty, which enables direct engagement between bakeries and their clients. Bakeries should actively engage customers through educational initiatives and community events aimed at raising awareness about food waste, particularly in the context of surplus bread. This collaborative approach fosters a sense of shared responsibility and encourages behavioural changes that support waste reduction at the local level. Moreover,

consumers play a role in driving demand for more sustainable practices. Educating them about the environmental and economic implications of food waste, as well as the benefits of supporting waste prevention initiatives, can lead to a meaningful shift in purchasing behaviours. As a practical example, bakeries could place informational signs on empty shelves in the evening to inform customers that most of the bread has been sold (Bartek et al., 2025). This strategy would communicate the bakery's commitment to minimising overproduction and reducing waste, reinforcing the importance of responsible consumption. At the same time, this could raise consumers' awareness about bread waste, not only at the store but also at home, where bread is among the top-three most wasted food products (Giordano et al., 2019; Fanelli, 2019).

In Finland, bakeries and retailers do not fully recognise the opportunity to influence consumers for example through the packaging. Bakeries have the knowledge on how to preserve bread, but so far retailers have been more active in communicating tips such as how to use older bread. Bakeries could contribute more by providing storage advice on packaging and sharing preservation tips in stores.

Furthermore, there are differences in date labels between Finland and Sweden. In general, a majority of bread in both countries is sold with a date label and only a fragment is sold without it for example through shop-in-shop bakeries. In Sweden, date labelling is used in two ways (Weber et al., 2023). Some bread is frozen right after production to be thawed before being placed in the shelves at retailers. This bread is usually labelled with best-before dates. Another type of bread is produced and delivered without being frozen and is then labelled with date of production as it is considered that consumers have a demand for as fresh bread as possible and therefore want this information. However, using date of production means that consumers will opt for the most recently produced bread over bread that was produced the day before, increasing the risk for the older bread to be left on the shelf and later wasted. On the other hand, in Finland, best-before dates are used, but consumers often confuse them with use-by dates, leading to unnecessary waste. Bakeries and retailers could clarify that bread is often still good past these dates and encourage consumers to rely on their senses to assess freshness. Additionally, both could offer recipes for using older bread. Retailers could also communicate that empty shelves mean no surplus and suggest alternative products, potentially using data-driven systems to provide real-time recommendations. Finally, educating consumers on bread waste issues could be linked to school level education where food literacy is generally cultivated as part of the curricula in Finland and Sweden (Sundin et al., 2024), and calls for integrating it in Italy have been made.

3.6. Surplus bread management

Managing the surplus bread currently presents a challenge in all three countries. This issue is particularly prominent in Italy, where the market is predominantly composed of small-scale bakeries that do not implement systematic quantification methods to measure daily surplus. Here, accurately assessing the actual amount of waste remains difficult. However, many bakeries adopt various strategies to prevent surplus bread. The most common solution is the reuse of surplus bread that is still suitable for human consumption or the production of breadcrumbs. This process requires additional costs and involves several steps. Due to these additional processing steps, the final selling price per kilogram of breadcrumbs is higher than that of regular bread. However, not all types of surplus bread are suitable for breadcrumb production, such as focaccia which cannot be effectively processed. Another common solution is the redistribution of surplus bread to charitable organizations, food banks, and local associations that assist people in need. While this practice is encouraged by Italian legislation (Giordano et al., 2020), bureaucratic and logistical challenges sometimes hinder its widespread adoption. Additionally, bakeries may lack the necessary infrastructure to efficiently store and transport surplus bread. Instead, surplus bread is often donated by retailers and large outlets (Cicatiello et al., 2017).

Moreover, digital solutions such as mobile applications have emerged as effective tools for surplus bread management. Platforms like "Too Good To Go" enable bakeries as well as retailers (see also D'Adamo et al., 2023) to sell unsold bread at discounted prices, reducing waste while maintaining economic value. This approach not only prevents surplus bread from being discarded but also raises consumer awareness about sustainable food practices. Similar mobile applications have been in use at retailers also in Finland. To support this, marketing campaigns that build consumer awareness of bread waste could be implemented by retailers. Previous research has found out that such campaigns may help reduce food waste, especially when using several communication channels and repeated messages (Young et al., 2018). Furthermore, in Germany there is a current initiative called 'Pact against food waste', which provides the retailers who comply to certain rules and targets for food waste reduction, a label they can use to signal this to their customers (Federal Ministry of Food and Agriculture, 2025). Sweden has for many years promoted biogas production and incineration for energy recovery as one of the main pathways for managing food waste, which in turn has led to a considerable portion of the national energy production being dependent on this input. Only a small part, roughly 2 %, of surplus bread is currently price-reduced or redistributed via charity organizations (Bartek et al., 2025). Donated surplus bread comes mostly directly from bakeries (and not from retailers). A large share of surplus bread sold under TBAs in Sweden is directed towards ethanol production, enabled via the separate collection of unsold bread and, to some extent, fuelled by a small economic benefit of selling this bread as a resource.

In contrast, Finland has a long-standing tradition of donating food to charity and today around a thousand food aid organizations operate in Finland (Ruoka-apu.fi, 2022), with approximately 90 % relying on surplus food from retailers and suppliers, including significant donations of bread (Korpela, 2020). As of December 2021, Finnish food producers and retailers have been required to redistribute surplus food for human consumption unless there are food safety risks or prohibitive costs. However, the problem is that currently due to oversupply, there are regional disparities in bread donations. Some food banks reject donations from retailers due to an oversupply of fresher bread from bakeries, while retailers' bread, nearing or past its best-before date, often goes to energy production (i.e., biogas). In other regions, there are not enough donating bakeries or retailers available for food banks.

To address this issue, new solutions should focus on higher levels of the waste hierarchy (Papargyropoulou et al., 2014), aiming to repurpose surplus bread for human consumption or other uses like animal feed. For example, in Finland, some initiatives have already emerged, such as processing surplus bread into beer, with the beer mash subsequently used for bread production. Similar incentives have also been attempted in Sweden (Brancoli et al., 2020), but they would require additional incentives to match the amount of surplus and waste needing to be recovered every year. These efforts require collaboration between stakeholders like breweries, retailers, and bakeries, as well as a re-evaluation of food labelling regulations, which small and medium-sized bakeries perceive as a barrier to reintroducing surplus or second-grade materials into production.

4. Conclusions

This study sought to investigate the current practices contributing to bread surplus and waste at the bakery-retail interface in three European countries, Finland, Italy, and Sweden, and propose targeted solutions. We identified six key issues pertinent to the bakery-retail interface. Fig. 1 outlines the proposed solutions in relation to the food use and waste hierarchy (European Commission et al., 2024).

The solutions mostly focus on the highest levels of the food waste hierarchy, and according to the hierarchy, these solutions should be prioritized. Especially in Sweden, surplus bread is managed through energy recovery, which is not the optimal solution. As bread waste related issues manifest differently in each country, the solutions were

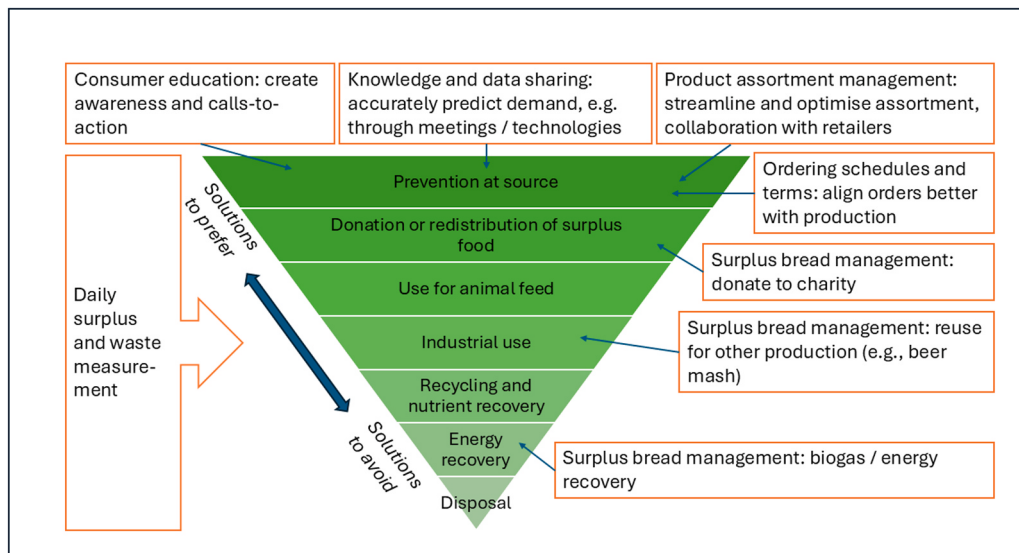


Fig. 1. Bread waste solutions identified in the study along the food waste hierarchy.

discussed in the stakeholder dialogues according to the specific market characteristics. Moving focus away from studying the causes of waste toward a solution-orientation, the study provides fruitful implications for both theory and practice. The study highlights that by bringing stakeholders from the bread supply chain together, mutual understanding of the potential solutions can be reached. This is the first crucial step to impact the surplus and waste problem at the bakery-retailer interface. Our study has illustrated how the solutions can be similar even though market-specific differences exist. The limitations of the study include that even though the data came from three countries allowing for cross-country comparisons, in each country the sample of bakeries and retailers involved was quite small. Thus, a quantitative study on a more representative sample from diverse countries could help validate the findings. Furthermore, the scalability of the suggested solutions and their impact on food waste levels should be investigated further, to prioritise the most impactful solutions. To this end, cases where these solutions are implemented in practice need to be studied more in-depth in order to evaluate the efficacy of the solution and the conditions allowing its successful adoption.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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