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# Wasting of Fresh-Packed Bread by Consumers—Influence of Shopping Behavior, Storing, Handling, and Consumer Preferences

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**Abstract:** There are few scientific papers dealing with the packaging of fresh bread and consumer preferences as to the packaging. There are also few scientific papers on consumer behavior regarding shopping routines, storing, and the use of fresh bread in connection with food waste from households. The primary scope of this study has been to gain new understanding and expertise when comparing the characteristics of consumers who report no wasting of fresh bread with those who report wasting a significant quantity of fresh bread every week. In addition, the authors have identified and analyzed the main reasons for wasting fresh-packed bread in Norway, and the way in which those reasons relate to varying aspects of consumer behavior. This expertise is important for those working in the development, production, and sale of food. It will enable them to take effective measures relating to the various consumer groups so as to prevent the waste of bread by consumers. A web-based questionnaire has been employed, with 1000 respondents, in order to collect data for the analyses. There were significant differences between the groups who reported wasting a significant amount of bread (seven slices or more a week) and groups who wasted no fresh bread at all. This was especially noticeable when focusing on age and household size. Other factors were shopping behavior, and the freezing and toasting of bread at home, which can minimize the wasting of bread. Low wasters employ clear strategies to avoid food waste (freezing, re-packing, and shopping) and these strategies are not seen in the group of high-wasters. The findings from this study may provide useful insight for those working with the development of packaging and products in the food industry, as well as those in the retail sector, as it identifies consumer preferences, viewpoints on packaging and attitudes towards the freshness of bread. As a sizeable group of consumers in this study stated that they use an additional plastic bag in addition to the original packaging, it is clear that consumers do not perceive the original packaging as being good enough to preserve the quality of fresh bread.

**Keywords:** food waste prevention; fresh bread; packaging development; consumer preference; shopping patterns

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## 1. Introduction

When studying food waste behavior, several different issues arise, and it is important not to consider this as an isolated phenomenon, but something that occurs in the mix of several variables. Economy (people can afford waste), overproduction of foods, surplus food, retail systems, availability of food, consumer behavior, consumer preferences, packaging, and waste management systems are all variables that increase food waste. Earlier studies have shown a number of different drivers for the

wasting of food in general. These include portion size, date labelling and shelf life, storage conditions and marketing strategies (buy two and get one free). Consumer characteristics—such as age, type of household, and family situation—are also important factors that influence the amount of food being wasted from households. Additionally, attitudes, life style, interests, and knowledge concerning food [1,2] show the complexity of the system that creates food waste. There is an increasing volume of literature regarding the role of consumers in food waste in general and the way in which this differs in relation to demographic factors and varying living conditions [3–7]. Some studies have shown that young people waste more food than older people, and that income, education, and gender influence the amount of food being wasted [3,4]. This was however not found in the study by de Hooge et al. [7], where younger people selected suboptimal food and wasted less food than older people, indicating that there could be a market for suboptimal bread ensuring that it was sold for a lower price, for example, the next morning. Other factors including the country of residence, environmental consciousness, and engagement in food preparation and cooking were also important [7].

The volume of research specifically focusing on the wasting of bread is far from extensive. There are, however, a few projects worth mentioning. Research into food waste in Norway has shown that Norwegian consumers each throw away about 5.5 kg of bread per year and 2.9 kg of other bakery products [8]. This is roughly 2.8 slices of fresh bread wasted per person in Norway every week or, in total, about 39 million loaves of bread per year in Norway. Numbers from Eurostat show that the annual consumption of bread in Norway is about 80 kg per person per year, which is higher than in most other countries in Europe. This figure might explain why wastage of fresh bread is so high in Norway, and contributes a major share of the total amount of food being wasted at home (about 19% [8]). Fresh bread is usually packed either in paper bags, plastic bags, or in a combination of paper with a plastic ‘window’ on the front, none of which can be closed. The design and/or functionality of packaging solutions in relation to the reduction of food waste has not been a topic in scientific papers. There are also only a few publications dealing with packaging solutions for fresh bread, and consumer preferences regarding bread quality and packaging, and behavior relating to the buying, storing, and waste of bread in households.

There is some research on suboptimal foods [7] with focus on the possibility of saving food that is oddly shaped, has a minor quality reduction, or a dent in the packaging, from going to waste, while offering these foods at a discounted price. The study by de Hooge et al. [7] is interesting as it concludes that consumers are open to purchasing products that deviate on the basis of shape, best-before-date, or damaged packaging so long as there is also a price discount for the reduction in quality.

Although there are relatively few studies of food waste by consumers in relation to bread, there are several studies available from other parts of the value chain. Stensgård & Hanssen [8] have shown that fresh bread is the product group with the highest percentage of turnover being wasted (more than 9% per year). Brancoli et al. [9] analyzed annual food waste in a supermarket in Sweden. Meat and bread are the two food product groups with the highest environmental footprint in supermarkets. In the case of bread this is principally due to the high volumes sold. Bread waste constituted an annual volume of 6.7 tons per year in one supermarket alone. Efforts towards reducing wastage of fresh bread can thus make a major impact on the environment.

Life cycle assessment studies clearly indicate that food waste prevention in general is the most important strategy for packaging optimization for most types of food [10]. The size of both the products offered and packaging solutions also have significance. To prevent food waste, it is important that the packaging has the correct barrier properties to ensure food safety, and if possible can be opened and closed by users to preserve the food.

The aim of this study was to increase understanding and knowledge regarding preferences, attitudes, and behavior of consumers, to be used in development of new and better packaging and packaging system and prevent food waste. Our aims were further to gain more insight in how consumers’ perception of current packaging solutions for fresh bread, of the shopping behavior of different categories of consumers, how fresh bread is stored at home, and how much fresh bread

is wasted. It is important to obtain greater insight into consumer preferences as well as knowledge concerning packaging, and to be able to use this in the development of new and better packaging and packaging systems, to prevent food waste.

## 2. Research Questions

Our study is an empirical study of the way in which consumer behavior can explain the wasting of bread and how this differs between different groups of consumers and their intentions.

The research questions in this study have been as follows:

1. What are the characterizing differences between Norwegian consumers who report no waste of fresh bread and those who waste more than average?
2. Is there any connection between consumers' shopping behavior and the amount of fresh bread consumers waste?
3. Is there any connection between consumer requirements concerning fresh bread and the amount of fresh bread consumers waste?
4. Is there any connection between consumer requirements in relation to packaging solutions for fresh bread and the amount of fresh bread consumers waste?
5. Is there any connection between consumer behavior at home regarding the storage and use of fresh bread and the amount of fresh bread consumers waste?

For detailed view of questions, please see Appendix A.

## 3. Methodology and Data Gathering

A standard methodological approach for consumer research was taken as the basis for this study, where approximately 1000 respondents in Norway were selected in a web-based survey carried out by Norstat within their web panel framework. The cohort was representative of the relevant population characteristics of the Norwegian population, and aged between 19 and 91 years old. The average age being 50. Five principal research themes were selected for focus as described in the previous section, with a total of 26 multi-response questions. The Likert model was used, with five alternative answers in addition to the 'do not know/will not answer' option for each question. In addition, the questionnaire was supplemented by a quantity of standard data regarding the personal characteristics of the respondents, comprising the area where they lived; the number of people in each household; age; education; civil status; employment status; income; and level of education. The respondents were also asked to estimate the number of slices of fresh bread that were wasted from their households, in categories ranging from 0, 1–3, 4–6, 7–10, and more than 10 per week. The frequency of respondents' bread wastage in each category is shown in Table 1 and indicates that a large group of consumers reported wasting no bread at all. These constituted about 43% of the total, whereas 30% reported wasting 1–3 slices per week.

The rationale behind the criteria for high-wasters was that figures for Norway showed that the per capita wastage of bread was approximately 5.5 kg in 2015 [5]. Based on the average weight of a loaf as being 0.75 kg, the number of slices per loaf as about 20, and number of people in average households in Norway as being 2.3, it was estimated that each household wasted about 6.5 slices of bread per week. High-wasters were then defined as reporting a greater waste of bread than average, that is to say, all the categories from 7–9 slices and upwards were included (Table 1) in the cross-tab analyses.

The step-wise regression analyses were carried out on all 1000 respondents and with focus on the correlation between the number of slices of fresh bread that were reported to be wasted by each respondent, and all the different characterization factors included in the survey.

The research is based both on what consumers themselves believe they intend to buy, use, and waste and what they believe they have in fact done.

**Table 1.** Frequency distribution of respondents regarding number of bread slices wasted per week from households.

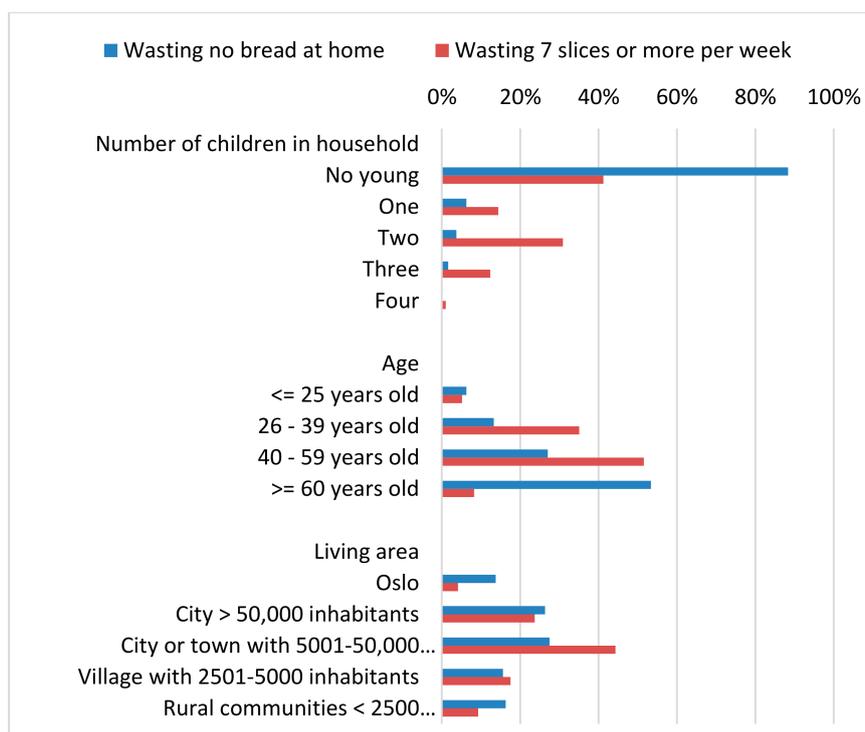
Number of Slices per Week Wasted from Household	Number of Respondents	Percentage of Respondents
Zero slices	429	42.9
1–3 slices	301	30.1
4–6 slices	140	14.0
7–9 slices	56	5.6
10–12 slices	22	2.2
More than 12 slices	19	1.9
Do not know	33	3.3
Total	1000	100.0

The data was analyzed statistically with SPSS 23.0, using cross-tab analyses and step-wise multiple regression analyses. The households were divided into two main groups, so as to enable the analysis of the habits, types of behavior, and social factors that characterized those who reported no bread wastage, and to allow a comparison with those of the group whose weekly bread wastage was greater than average: Low-wasters, reporting no waste of fresh bread at all from households (N = 429 respondents); and high-wasters, who reported wasting seven bread slices per week or more (N = 97 respondents).

## 4. Results

### 4.1. Consumer Characteristics of Respondents in the Low and High Wasters Categories

The predominant results of the analyses of the population characteristics of respondents answering that they wasted no bread, and of those who answered that they waste large amounts of bread (seven slices or more per week) are shown in Figure 1 and Table 2. There is a higher tendency among men than women to report that their households are among the high-wasters (58.8% vs. 41.2%), but the difference is not statistically significant. High-wasters are also more often living in medium-sized towns and cities (15–50,000 inhabitants) than in Oslo or other larger cities or rural areas (statistical significant, Pearson Chi-square = 25,739,  $p = 0.041$ ). The number of people in households has a significant influence on wasting behavior, as the low-wasters are overrepresented among the small households (1–2 people), whereas the high-wasters dominate in households with 3–5 people (Pearson Chi-square 122.31,  $p = 0.000$ ). The same pattern is seen for the number of children aged 18 years or younger, where 88.3% of the low-wasters are found in households without young children at home (Table 2). High-wasters, on the other hand, dominate in households with 1–3 young children (Chi-square test 129.65;  $p = 0.000$ ). The income level in a household also has a significant influence on waste behavior, as the low-wasters are more often found in households with a total income of less than 600,000 NOK, whereas the high-wasters dominate in middle income households (Pearson Chi-square 68.29;  $p = 0.000$ ). The same can be said of employment status, where high-wasters are most often found among full-time employees (71.1%), while low-wasters are found among retired people (34.5%), among full-time employees (34.5%), and among part time employees and people living on social security (9.1% and 9.3% respectively; Pearson Chi-square 1486;  $p = 0.000$ ). Civil status also reveals a significant difference between high- and low-wasters, where the high-wasters dominate in households with children (63.9%), and low-wasters are primarily found in households with childless couples (45.0%) and among single person households (33.6%; Pearson Chi-square 1486;  $p = 0.000$ ). The level of education did not show any division between low- and high-wasters, but age had a significant effect, as 53.4% of the low-wasters were 60 or older, while 51.5% of the high-wasters were in the 40–59 age group and 35.1% in the 26–39 group (Table 2).



**Figure 1.** Characteristics of low-wasters and high-wasters with regard to the number of children in households, age categories, and type of living area.

**Table 2.** Consumer characteristics of respondents wasting no fresh bread (low-wasters) and those wasting seven slices or more per week (high-wasters).

Consumer Characterization Factor	Number of Respondents	Wasting No Bread at Home	Wasting 7 Slices or More per Week	Total for the Whole Sample	Pearson Chi-Square and Significance
<i>Gender</i>					5.106; $p = 0.106$
Women	283	52.2%	41.2%	50.6%	
Men	276	47.8%	58.8%	49.4%	
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<i>Type of living area</i>					25.739; $p = 0.041$
Oslo	70	13.8%	4.1%	12.5%	
City with more than 50,000 inhabitants	146	26.3%	23.7%	26.1%	
City with 5001–50,000 inhabitants	171	27.5%	44.3%	30.6%	
Village with 2501–5000 inhabitants	86	15.6%	17.5%	15.4%	
Rural areas with less than 2500 inhabitants	83	16.3%	9.3%	14.8%	
Not answered	3	0.5%	1.0%	0.5%	
559					
<i>Number of persons in households</i>					122.31; $p = 0.000$
One	168	34.0%	13.4%	30.1%	
Two	249	49.9%	22.7%	44.5%	
Three	58	8.4%	16.5%	10.4%	
Four	55	5.4%	32.0%	9.8%	
Five or more	28	2.1%	15.5%	5.0%	
Not answered	1	0.2%	0.0%	0.2%	
559					

Table 2. Cont.

Consumer Characterization Factor	Number of Respondents	Wasting No Bread at Home	Wasting 7 Slices or More per Week	Total for the Whole Sample	Pearson Chi-Square and Significance
<i>Number of persons in households 18 years or younger</i>					<b>129.65; <math>p = 0.000</math></b>
No young	445	88.3%	41.2%	79.6%	
One	45	6.3%	14.4%	8.1%	
Two	47	3.7%	30.9%	8.4%	
Three	21	1.6%	12.4%	3.8%	
Four	1	0.0%	1.0%	0.2%	
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<i>Total net income in household</i>					<b>68.29; <math>p = 0.0000</math></b>
0–300 NOK	59	13.1%	1.0%	10.6%	
301–600 NOK	156	30.5%	15.5%	27.9%	
601–900 NOK	132	23.3%	29.9%	23.6%	
901–1200 NOK	88	13.3%	26.8%	15.7%	
1201–1500 NOK	15	1.4%	9.3%	2.7%	
>1500 NOK	7	0.7%	4.1%	1.3%	
Not answered	102	17.7%	13.4%	18.2%	
	559				
<i>Employment status</i>					<b>78.74; <math>p = 0.0000</math></b>
Full time student	39	6.5%	5.2%	7.0%	
Full time employee	230	34.5%	71.1%	41.1%	
Part time employee	48	9.1%	5.2%	5.2%	
Working in own company	22	3.3%	7.2%	3.9%	
Retired	156	34.5%	4.1%	27.9%	
Unemployed looking for new job	13	1.6%	3.1%	2.3%	
Home	5	1.2%	0.0%	0.9%	
Trygdet	46	9.3%	4.1%	0.0%	
	559				
<i>Civil status</i>					<b>148.6; <math>p = 0.0000</math></b>
Single	174	33.6%	16.5%	31.1%	
Couple without children at home	221	45.0%	17.5%	39.5%	
Couple with childret at home	116	11.4%	63.9%	20.8%	
Lving at home with parents	10	1.6%	0.0%	1.8%	
Widow/	20	4.4%	1.0%	3.6%	
Not answered	18	4.0%	1.0%	3.2%	
	559				
<i>Education—highest level</i>					<b>14.38; <math>p = 0.1565</math></b>
Basic school	34	6.3%	6.1%	6.1%	
College	163	30.5%	27.3%	29.2%	
University college, BSc level (3 years)	174	29.4%	24.2%	31.1%	
University MSc level (4–5 years)	138	24.7%	36.4%	24.7%	
University, PhD level	40	7.5%	0.0%	7.2%	
Other types of education	10	1.6%	1.8%	1.8%	
	559				
<i>Age category</i>					<b>85.75; <math>p = 0.0000</math></b>
≤25 years old	37	6.3%	5.2%	6.6%	
26–39 years old	103	13.3%	35.1%	18.4%	
40–59 years old	173	27.0%	51.5%	30.9%	
60+ years old	246	53.4%	8.2%	44.0%	
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#### 4.2. Shopping Behavior and Preferences of Low- and High-Wasters with Regard to Fresh Bread

Questions were put to consumers in order to analyze whether there are any correlations between the amount of wasted bread from households and the household's shopping behavior and preferences in relation to fresh bread. The most noteworthy results are shown in Tables 3 and 4. Shopping behavior did in general create a greater distinction between low- and high-wasters than preferences regarding bread quality, where only soft crumb and long shelf life showed statistical differences between the groups.

In general, most respondents prefer to buy fresh bread in supermarkets, followed by special bakery shops. High-wasters had a greater preference for buying their fresh bread in supermarkets than low-wasters (64.9% and 45.9% strongly agreed respectively) and thus created a significant difference between the groups in relation to this question (Pearson Chi-square 23.39;  $p = 0.0094$ ; Table 3). High-wasters bought bread much more frequently than low-wasters, as 8.2% bought fresh

bread every day, whereas 44.2% bought fresh bread 3–4 times a week (Table 3). Among low-wasters, only 0.5% bought bread every day, while 6.1% bought fresh bread 3–4 times a week. 36.6% of the Low-Wasters bought fresh bread less often than once a week, whereas only 4.1% of high-wasters bought fresh bread as infrequently as that. There were also slight differences between the two groups regarding the number of fresh loaves bought per grocery shopping trip, where 5.3% of high-wasters bought five or more loaves per trip, as against 2.6% of low-wasters. The answers to both of these two last questions revealed significant differences between the two groups (Pearson Chi-square 212.1;  $p = 0.000$  and Pearson Chi-square 37.428;  $p = 0.000$  respectively; Table 3).

**Table 3.** Consumer shopping behavior of respondents wasting no bread and those wasting seven slices or more per week.

Consumer Characterization Factor	Number of Respondents	Wasting No Bread at Home	Wasting 7 Slices or More per Week	Total for the Whole Sample	Pearson Chi-Square and Significance
<i>Normally buy vacuum packed bread</i>					
Highly agree	8	1.4%	2.1%	1.4%	22.385; $p = 0.0133$
Agree	13	1.9%	4.1%	2.3%	
Neutral	57	9.8%	11.3%	10.2%	
Disagree	103	17.0%	20.6%	18.4%	
Highly disagree	316	57.3%	60.8%	56.5%	
Not answered	62	12.6%	1.0%	11.1%	
	559				
<i>Normally buy fresh baked bread in retail shops</i>					
Highly agree	273	45.9%	64.9%	48.8%	23.39; $p = 0.0094$
Agree	158	28.9%	25.8%	28.3%	
Neutral	47	8.4%	6.2%	8.4%	
Disagree	16	3.0%	2.1%	2.9%	
Highly disagree	17	4.0%	0.0%	3.0%	
Not answered	48	9.8%	1.0%	8.6%	
	559				
<i>Normally buy fresh bread in bakery shops</i>					
Highly agree	105	18.9%	20.6%	18.8%	17.753; $p = 0.059$
Agree	120	22.1%	20.6%	21.5%	
Neutral	128	21.4%	25.8%	22.9%	
Disagree	79	12.6%	18.6%	14.1%	
Highly disagree	71	13.5%	12.4%	12.7%	
Not answered	56	11.4%	2.1%	10.0%	
	559				
<i>Number of times per week buying fresh bread</i>					
Every day	12	0.5%	8.2%	2.1%	212.51; $p = 0.0000$
3–4 times a week	72	6.1%	44.3%	12.9%	
1–2 times a week	259	48.3%	41.2%	46.3%	
Less than 1 times a week	171	36.6%	4.1%	30.6%	
Never	41	8.6%	2.1%	7.3%	
Not answered/don't know	4	0.0%	0.0%	0.7%	
	559				
<i>Number of breads bought per shopping</i>					
One	303	58.7%	56.8%	58.5%	37.428; $p = 0.000$
Two	113	22.7%	21.1%	21.8%	
Three–four	80	15.3%	16.8%	15.4%	
Five or more	15	2.6%	5.3%	2.9%	
Not answered/don't know	48	0.8%	0.0%	1.4%	
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#### 4.3. Quality Preferences for Fresh Bread

There were also a few distinct differences between the quality factors given preference by low-wasting and high-wasting respondents. Low-wasting consumers were significantly less critical regarding the availability of their favorite bread types in the shops (62.2% as against 77.3% responding that this was highly important or important; Pearson Chi-square 29.44;  $p = 0.001$ ; Table 4), they were also less critical regarding the soft crumbs of fresh bread (35.5 as against 52.6% saying that this was highly important or important; Pearson Chi-square 24.55;  $p = 0.006$ ). Long shelf life was

however regarded as being highly important or important by 33.1% of low-wasting and 39.2% of high-wasting consumers (Pearson Chi-square 22.24;  $p = 0.014$ ; Table 3). Other quality related factors showed insignificant deviations between low-wasting and high-wasting respondents in the study. It is interesting to notice that price per loaf was only said to be highly important or important by about 30% of the respondents, whereas the degree of freshness was said to be important or highly important by more than 76% of the respondents (Table 4).

**Table 4.** Preferences of bread qualities among respondents wasting no bread and those wasting more than seven slices of bread per day.

Consumer Characterization Factor	Number of Respondents	Wasting No Bread at Home	Wasting 7 Slices or More per Week	Total for the Whole Sample	Pearson Chi-Square and Significance
How important is it that the shop have your favorite bread type?					29.443; $p = 0.001$
Highly important	148	27.5%	25.8%	26.5%	
Important	212	34.7%	51.5%	37.9%	
Neutral	85	14.5%	16.5%	15.2%	
Less important	43	8.9%	3.1%	7.7%	
Unimportant	53	11.2%	3.1%	9.5%	
Not answered/do not know	18	3.3%	0.0%	3.2%	
	559				
<i>Price per bread</i>					15.002; $p = 0.132$
Highly important	61	11.4%	7.2%	10.9%	
Important	166	27.7%	39.2%	29.7%	
Neutral	161	30.3%	23.7%	28.8%	
Less important	88	15.9%	17.5%	15.7%	
Unimportant	56	9.6%	11.3%	10.0%	
Not answered/do not know	27	5.1%	5.1%	4.8%	
	559				
<i>Degree of freshness of bread in shops</i>					14.808; $p = 0.139$
Highly important	238	41.3%	50.5%	42.6%	
Important	192	33.6%	36.1%	34.3%	
Neutral	65	12.1%	9.3%	11.6%	
Less important	22	4.9%	1.0%	3.9%	
Unimportant	14	2.8%	2.1%	2.5%	
Not answered/do not know	28	5.4%	1.0%	5.0%	
	559				
<i>Crispy crust</i>					11.469; $p = 0.322$
Highly important	107	18.6%	19.6%	19.1%	
Important	176	31.2%	36.1%	31.5%	
Neutral	137	24.7%	22.7%	24.5%	
Less important	67	11.4%	15.5%	12.0%	
Unimportant	43	8.4%	5.2%	7.7%	
Not answered/do not know	29	5.6%	1.0%	5.2%	
	559				
<i>Smelling fresh bread</i>					13.896; $p = 0.178$
Highly important	139	23.5%	28.9%	24.9%	
Important	204	35.7%	42.3%	36.5%	
Neutral	131	23.8%	21.6%	23.4%	
Less important	33	6.3%	11.3%	5.9%	
Unimportant	21	4.7%	8.2%	3.8%	
Not answered/do not know	31	6.1%	2.1%	5.5%	
	559				
<i>Soft core of bread</i>					24.552; $p = 0.006$
Highly important	62	9.6%	19.6%	11.1%	
Important	154	25.9%	33.0%	27.5%	
Neutral	159	29.4%	25.8%	28.4%	
Less important	79	15.4%	11.3%	14.1%	
Unimportant	69	13.3%	8.2%	12.3%	
Not answered/do not know	36	6.5%	2.1%	6.4%	
	559				
<i>Long shelf life/conservation of freshness</i>					22.236; $p = 0.014$
Highly important	50	9.8%	6.2%	8.9%	
Important	143	23.3%	33.0%	25.6%	
Neutral	152	26.1%	33.0%	27.2%	
Less important	104	18.2%	21.6%	18.6%	
Unimportant	81	17.0%	5.2%	14.5%	
Not answered/do not know	29	5.6%	1.0%	5.2%	
	559				

#### 4.4. Consumer Preferences Regarding Packaging and Packaging Materials

The study also focused on preferences shown by the different consumer groups concerning packaging solutions and packaging materials for fresh bread, and it showed clearly that high-wasting consumers were less environmentally aware with regard to packaging solutions (potential for recycling, made of an environmental friendly material) than non-wasting people, indicating some type of connection between wasteful behavior and environmental attitudes. High-wasting consumers had a significantly higher response than low-wasters to being able to smell fresh bakery products from bread bags (40.2% as against 25.0% answered that this was highly important or important; Pearson Chi-square 26.17;  $p = 0.004$ ; Table 5), whereas no-wasting consumers clearly preferred bags made from environmentally friendly materials (38% as against 25.8% highly important or important; (Pearson Chi-square 25.03;  $p = 0.005$ ). High-wasting consumers had significantly lower preferences for the use of recycled materials than low-wasting (28.5% as against 43.3% responded that this was unimportant or less important; (Pearson Chi-square 26.10;  $p = 0.004$ ) and there was a similar pattern with recyclability of packaging after use (21.4% vs. 39.2% responded unimportant or less important; (Pearson Chi-square 26.38;  $p = 0.003$ ; Table 4). Again, there were insignificant differences between the two groups with regard to the quality requirements of packaging solutions, but it is important to note that as many as 57.6% of all respondents said that it was highly important or important that the bags preserve the freshness of the bread. It is also interesting that more than 75% of the respondents said they wanted to see the bread in the bags (75.8%) while only 30% said they preferred closed bags to protect the bread (Table 5).

**Table 5.** Preferences of packaging related properties among respondents wasting no bread and those wasting seven slices or more per week.

Consumer Characterization Factor	Number of Respondents	Wasting No Bread at Home	Wasting 7 Slices or More per Week	Total for the Whole Sample	Pearson Chi-Square and Significance
<i>Closed pouch with protection of bread</i>					
Highly important	50	10.0%	4.1%	8.9%	12.239; $p = 0.269$
Important	118	21.0%	24.7%	21.1%	
Neutral	182	32.6%	29.9%	32.6%	
Less important	113	18.9%	25.8%	20.2%	
Unimportant	66	12.1%	12.4%	11.8%	
Not answered/do not know	30	5.4%	5.4%	5.4%	
	559				
<i>Pouch conserve freshness of bread</i>					
Highly important	111	19.1%	23.7%	19.9%	14.846; $p = 0.138$
Important	211	36.6%	41.2%	37.7%	
Neutral	133	24.0%	23.7%	23.8%	
Less important	46	9.6%	3.1%	8.2%	
Unimportant	28	4.9%	7.2%	5.0%	
Not answered/do not know	30	5.8%	1.0%	5.4%	
	559				
<i>Able to touch and feel the freshness of bread</i>					
Highly important	47	9.8%	19.6%	11.1%	24.552; $p = 0.006$
Important	117	23.3%	33.0%	27.5%	
Neutral	161	26.1%	25.8%	28.4%	
Less important	107	18.2%	11.3%	14.1%	
Unimportant	96	17.0%	8.2%	12.3%	
Not answered/do not know	31	5.6%	2.1%	6.4%	
	559				
<i>Able to see the bread in the pouch</i>					
Highly important	180	31.2%	38.1%	32.2%	13.734; $p = 0.185$
Important	244	43.6%	44.3%	43.6%	
Neutral	76	13.1%	14.4%	13.6%	
Less important	18	4.0%	1.0%	3.2%	
Unimportant	13	2.8%	1.0%	2.3%	
Not answered/do not know	28	5.4%	1.0%	5.0%	
	559				

Table 5. Cont.

Consumer Characterization Factor	Number of Respondents	Wasting No Bread at Home	Wasting 7 Slices or More per Week	Total for the Whole Sample	Pearson Chi-Square and Significance
<i>Able to smell the bread in the pouch</i>					
Highly important	55	9.1%	11.3%	9.8%	<b>26.174; <math>p = 0.004</math></b>
Important	105	15.9%	28.9%	18.8%	
Neutral	185	34.7%	26.8%	33.1%	
Less important	113	22.4%	16.5%	20.2%	
Unimportant	70	12.4%	14.4%	12.5%	
Not answered/do not know	31	5.6%	2.1%	5.5%	
	559				
<i>Environmental friendly packaging</i>					
Highly important	61	12.6%	5.2%	10.9%	<b>25.025; <math>p = 0.005</math></b>
Important	138	26.1%	20.6%	24.7%	
Neutral	184	32.9%	33.0%	32.9%	
Less important	68	11.7%	15.5%	12.2%	
Unimportant	80	11.4%	24.7%	14.3%	
Not answered/do not know	28	5.4%	1.0%	5.0%	
	559				
<i>Packaging from recycled materials</i>					
Highly important	44	8.4%	3.1%	7.9%	<b>26.096; <math>p = 0.004</math></b>
Important	135	25.2%	24.7%	24.2%	
Neutral	179	32.6%	27.8%	32.0%	
Less important	81	14.7%	15.5%	14.5%	
Unimportant	92	13.8%	27.8%	16.5%	
Not answered/do not know	28	5.4%	1.0%	5.0%	
	559				
<i>Packaging materials recyclable after use</i>					
Highly important	69	13.8%	7.2%	12.3%	<b>26.379; <math>p = 0.003</math></b>
Important	158	29.1%	25.8%	28.3%	
Neutral	165	30.5%	26.8%	29.5%	
Less important	64	10.7%	15.5%	11.4%	
Unimportant	75	10.7%	23.7%	13.4%	
Not answered/do not know	28	5.1%	1.0%	5.0%	
	559				

#### 4.5. Consumer Behavior with Regard to Storing, Repackaging, and Use of Fresh Bread by Two Groups of Consumers

This part of the study showed significant and very interesting differences between the two groups of consumers, which are important in understanding the type of behavior that can explain why some groups of consumers waste more fresh bread than others (Table 6). Low-wasters report to repack bread significantly more often at home (47.6% do this always or very often) than those who waste seven slices or more (34.0%). There is also a significant difference between the two groups with regard to the freezing of bread at home, where 59.6% of the group with no wastage do this always or very often, whereas only 27.9% of the high-wasters do this always or very often. There is also a tendency for low-wasters to use a toaster more often so as to improve the quality of dry bread (21.7% reported doing this always or very often) when compared with the group of high-wasters (12.4%). Lastly, the group of high-wasters showed a much greater willingness to pay extra for packaging that increased the freshness of the bread at home, where 42.1% of high-wasters would pay 20 cents (Euro) extra or more per loaf, while 62% of the no-wasters would not pay anything extra at all for improved packaging (Table 6).

**Table 6.** Differences in packing, storing, and processing behavior between respondents wasting no bread and those wasting seven slices or more per week.

Consumer Characterization Factor	Number of Respondents	Wasting No Bread at Home	Wasting 7 Slices or More per Week	Total for the Whole Sample	Pearson Chi-Square and Significance
<i>Slices the bread in shop</i>					<b>19.37; <math>p = 0.036</math></b>
Always	167	30.5%	27.8%	29.9%	
Very often	82	14.5%	15.5%	14.7%	
Often	51	7.7%	13.4%	9.1%	
Very seldom	83	13.8%	21.6%	14.8%	
Never	151	28.7%	21.6%	27.0%	
Not answered/do not know	25	4.9%	0.0%	4.5%	
	559				
<i>Repack bread with extra pouch outside original packaging</i>					<b>22.431; <math>p = 0.013</math></b>
Always	162	13.8%	19.6%	15.4%	
Very often	86	13.8%	17.5%	14.0%	
Often	67	12.4%	16.5%	13.4%	
Very seldom	115	19.6%	19.6%	19.0%	
Never	99	34.7%	26.8%	32.9%	
Not answered/do not know	30	5.8%	0.0%	5.4%	
	559				
<i>Repack bread with new plastic pouch at home</i>					<b>29.963; <math>p &lt; 0.001</math></b>
Always	86	31.5%	21.6%	29.0%	
Very often	78	16.1%	12.4%	15.4%	
Often	75	11.9%	11.3%	12.0%	
Very seldom	106	19.3%	28.9%	20.6%	
Never	184	15.6%	25.8%	17.7%	
Not answered/do not know	30	5.6%	0.0%	5.4%	
	559				
<i>Freezing parts of the bread when still fresh</i>					<b>82.176; <math>p &lt; 0.001</math></b>
Always	166	36.8%	5.2%	29.7%	
Very often	128	22.8%	22.7%	22.9%	
Often	101	16.8%	22.7%	18.1%	
Very seldom	88	13.3%	26.8%	15.7%	
Never	51	5.6%	22.7%	9.1%	
Not answered/do not know	25	4.7%	0.0%	4.5%	
	559				
<i>Using toaster to use bread with reduced freshness</i>					<b>28.945; <math>p = 0.001</math></b>
Always	43	8.9%	3.1%	7.7%	
Very often	65	12.8%	9.3%	11.6%	
Often	99	16.3%	23.7%	17.7%	
Very seldom	181	30.3%	40.2%	32.4%	
Never	143	26.6%	23.7%	25.6%	
Not answered/do not know	28	5.1%	0.0%	5.0%	
	559				
<i>Paying willingness for packaging which conserve freshness better</i>					<b>69.620; <math>p &lt; 0.001</math></b>
No increased cost	301	62.0%	23.7%	53.8%	
Up to 5 cents per bread	30	5.1%	4.1%	5.4%	
Up to 10 cents per bread	68	11.9%	14.4%	12.2%	
Up to 20 cents per bread	55	8.2%	16.5%	9.8%	
More than 20 cents per bread	105	12.8%	41.2%	18.8%	
	559				

#### 4.6. Importance of Factors Describing Consumer Characteristics, Shopping Behavior, Preferences for Bread and Packaging, and Consumer Behavior in Explaining the Amount of Bread Being Wasted by Consumers

Step-wise multiple regression analyses have been utilized to rank the factors analyzed in Sections 4.1–4.4 and identify which are most important in differentiating between low- and high-wasters among consumers. The model was applied for each of the analyzed areas, with a basis in the correlation between the different characterization factors and the number of fresh bread slices reported to be wasted by the households.

Table 7 shows that among the characterization factors of the respondents in the study, the number of people 18 or younger in households was selected as the primary factor by the model (correlation with number of bread slices wasted 0.274), followed by age of the respondent (correlation coefficient =  $-0.229$ ) and finally the civil status of the respondent (correlation coefficient =  $-0.06$ ). The multiple regression analyses thus indicate clearly that household size, and the number of children in the family in particular, are the most important factors leading to high amounts of fresh bread

being wasted, whereas age has the opposite effect, where the amount of food waste decreases with the increasing age of the respondents (Table 7).

**Table 7.** Multiple regression analyses of consumer characteristics with number of bread slices wasted per week by consumers.

Population Characterisation Factor	Correlation with Number of Bread Slices Wasted	Significance	Rank in Stepwise Regression Model
Gender	−0.033	0.148	
Country region	−0.012	0.351	
Urban or rural living place	−0.012	0.356	
Number of people in household	0.084	<b>0.004</b>	
Number of people younger than 18 years in household	0.274	<b>0.000</b>	1
Total gross income in household before tax	0.067	<b>0.018</b>	
Employment status	−0.180	<b>0.000</b>	
Civil status	−0.060	<b>0.028</b>	3
Education level	0.023	0.237	
Age	−0.229	<b>0.000</b>	2

Taking the same approach with factors describing shopping behavior and preferences for fresh bread by consumers showed that frequency of shopping per week and the number of loaves bought per shopping trip were the two most important factors explaining the number of bread slices wasted per week (Table 8).

**Table 8.** Multiple regression analyses of consumer shopping behavior with number of bread slices wasted per week by consumers.

Shopping Routines	Correlation with Number of Bread Slices Wasted	Significance	Rank in Stepwise Regression Model
Buy mostly vacuum packed bread	−0.049	0.0662	
Buy mostly fresh bread in supermarkets	−0.071	<b>0.0141</b>	
Buy mostly fresh bread in bakeries	−0.001	0.4914	
How often do you normally buy fresh bread	−0.246	<b>0.0000</b>	1
How many fresh loaves do you normally buy on each grocery shopping trip	0.049	0.0661	2

Lastly, by using stepwise regression analyses on consumer routines and behavior regarding repacking, storing, and preparing of bread at home, it can be seen that freezing of fresh bread at home was the most important factor in explaining the number of slices of bread being wasted by consumers, followed by the repacking of fresh bread in shops or at home (Table 9).

**Table 9.** Multiple regression analyses of consumer routines for handling fresh bread in shops and at home.

Consumer Routines at Home	Correlation with Number of Bread Slices Wasted	Significance	Rank in Stepwise Regression Model
Slices bread in the shop	−0.012	0.354	
Repack with new plastic bag in stead of original packaging	0.083	<b>0.004</b>	2
Repack with new extra plastic bag at home	−0.067	<b>0.018</b>	3
Freeze part or whole loaves at home	0.226	<b>0.000</b>	1
Use toaster to refresh the bread at home	0.049	0.061	

## 5. Discussion and Conclusions

This study is one of the few detailed studies on consumer behavior and attitudes with regard to food waste in relation to freshly baked bread. The large amount of bread wasted in Norway could be a consequence of the fact that data from Eurostat indicates that bread consumption is higher in Norway than in many other parts of Europe, but the same picture seems also to apply in Sweden and Finland. There, however, the amount of fresh bread wasted is lower [11]. It is therefore important to

identify both the root causes as to why so much fresh bread is wasted, and who is represented in this high-wasting group.

The type of study being carried out through web-based panels for consumer surveys do, of course, have some weaknesses. Firstly, respondents are probably more positive regarding their own behavior and attitudes than the real situation would reveal when they are making realistic, practical choices in life. This could probably make the whole study too optimistic with regard to the respondents' own behavior, how much bread is wasted, and their own attitudes and values. The weighted average of how many slices of bread wasted per week in Norwegian households is about 2.3 based on data from this survey, whereas the estimate of wasted slices per households based on waste morphological studies [8] is about 3.45 slices per person per day, or about 7.9 slices per household per day in Norway. It is not known if this is a systematic underestimate within the entire sample or if it underestimates more for one group than others, but as the sample size is quite large, it is assumed to be levelled out over the whole sample. Secondly, there is also the question as to whether web-based surveys give representative samples and cohorts of the whole Norwegian population, or if some groups are systematically underrepresented. Compared with the average demographic figures for the entire Norwegian population, the 1000 people in the sample covered by the web panel seem to be representative regarding most factors.

This study shows quite clearly that young families with small or young children are the key groups that require focus in Norway, in line with other studies being done both in Norway and in many other countries [3,4,12]. High-wasting people buy bread more frequently than low-wasting people and they also buy more bread per shopping trip. The price of bread has increased significantly over the last years in Norway, giving incentives to reduce wasting of fresh bread by those consumers that buy the most bread.

The study also indicates two important characteristics of high-wasters when compared with low-wasters. This the fact that they have a higher preference for fresh bread and that they are less environmentally conscious, as shown by their lack of preferences for environmentally friendly packaging. Even more important is the fact that they are less oriented towards proper storage of fresh bread at home, by freezing it in parts or by using a toaster to make the older bread more edible. Typical high-wasters are probably found in families with little time and relatively high income, with a large volume of bread being consumed per day and per week because of there being many young family members.

The findings that young people in the age group 25–49 are the worst with regard to food waste behavior are in line with other studies, both in Norway [8] and in the UK [3]. These show, however, contrary findings to [7] in that young people are more positive to food items which look less perfect than standard products. Young people are also much more focused on wasting products that have passed their expiry date [5,13], although this is not directly relevant to fresh bread where a date label system is not used. The same type of mechanism is however relevant for fresh bread, where it is easy to select a new day-fresh loaf instead of yesterday's dryer and less tasty bread.

Packaging might be a driver towards increased food waste where the packaging is damaged in the distribution phase, if the primary or secondary packaging is too big or if the packaging is not optimal with regard to protection of the food [10,13,14]. One key objective of this study has been to learn more about how better packaging solutions can contribute to less food waste at a household level and with reduced environmental burdens throughout the life cycle. This study indicates that better packaging solutions can help consumers waste less fresh bread, especially the high-wasters who are major consumers of bread, but also have the least developed routines at home for storing and processing fresh bread by freezing and toasting. They are however positive towards selecting new types of packaging that could prevent loss of freshness for a longer time, and also display a high level of willingness to pay for such a type of packaging. Consumers were not asked explicitly if the loaf was too big, and whether smaller loaves with smaller packaging solutions could have reduced food waste. This is certainly a factor that should be followed up in further studies in the area. Hanssen et al. [15]

have shown that the total cost of packaging of all bread that is sold in Norway is only about 9% of the cost of bread being wasted. In the case of GHG-emissions, the total burden of all packaging used for bread distribution in Norway is on the same scale as GHG-emissions from production and distribution of about 70% of all the bread being wasted in Norway. There is thus a sizeable potential for the development of new packaging solutions, both from an economic and an environmental point of view, which could cost significantly more if they contributed to a reduction in the amount of fresh bread being wasted.

To conclude, this research contributes with an insight into consumer behavior and attitudes relating to the waste of fresh bread. Based on all the available quantitative data, it is possible to develop strategies and ideas for packaging as well as products that better accommodate what the different groups of consumers want and need. As the study also identifies the demographic characteristics of the groups of consumers, it is easier to target the high-wasters and devise solutions which can be tailor-made for them. The findings from this study will thus provide useful insight for those who work with the development of packaging and products within the food industry, as well as supermarket chains, as it identifies consumer preferences and viewpoints on packaging and quality factors relating to fresh bread.

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**Conflicts of Interest:** The authors declare no conflicts of interest.

## Appendix A

Detailed questionnaire:

1. To what extent are you responsible for purchasing bread to your household?
2. How often do you normally purchase fresh bread in your household?
3. How many loaves of bread do you usually purchase when you go grocery shopping?
4. How important are the following factors in your choice of fresh bread?
  - a. Price
  - b. That the bread is fresh (in the store)
  - c. That the bread has a crispy crust
  - d. That the bread smells freshly baked
  - e. That the bread is soft when you squeeze it
5. How important are the following factors regarding how freshly baked bread is packaged?
  - a. That the loaf is safely packaged so it can't be contaminated
  - b. That the bread has a packaging that preserves freshness so long as?
  - c. That you can touch and feel the bread
  - d. That you can see the bread
  - e. That you can smell the bread
  - f. That the packaging is environmentally friendly
6. To what extent do you do the following with freshly baked bread?
  - a. Cut up the loaf in slices at the store
  - b. Remove the original packaging and replace it with a plastic bag at home

- c. Re-pack with a plastic bag outside the original packaging at home
  - d. Freeze parts of the bread
  - e. Use a toaster when the bread becomes dry
7. In Norway an average of eight slices of bread per person per week are thrown away, how much do you think is normally wasted from your household?
- a. None, 1–3 slices
  - b. 4–6 slices
  - c. 7–9 slices
  - d. 10–12 slices
  - e. More than 12 slices
  - f. I don't know
8. How much would you be willing to pay extra for a loaf of bread that has a packaging that will keep the bread fresher for longer at home?
- a. 0
  - b. Up to 50 øre
  - c. Up to 1 krone
  - d. Up to 2 kroner
  - e. More than 2 kroner

In this paper, the focus is on the results from questions 4, 5, and 6.

## References

1. Thyberg, K.L.; Tonjes, D.J. Drivers of food waste and their implications for sustainable policy development. *Resour. Conserv. Recycl.* **2016**, *106*, 110–123. [[CrossRef](#)]
2. Hebrok, M.; Boks, C. Household food waste: Drivers and potential intervention points for design—An extensive review. *J. Clean. Prod.* **2017**, *151*, 380–392. [[CrossRef](#)]
3. Quedsted, T.E.; Marsh, E.; Stunell, D.; Parry, A.D. Spaghetti soup: The complex world of food waste behaviours. *Resour. Conserv. Recycl.* **2013**, *79*, 43–51. [[CrossRef](#)]
4. Stensgård, A.E.; Hanssen, O.J. *Edible Food Waste in Norway 2014—Status and Trends 2009–2014. Report from the ForMat-Prosjektet*; Ostfold Research, OR.01.15; Østfoldforskning: Fredrikstad, Norway, 2014.
5. Stensgård, A.; Hanssen, O.J. *Avoidable Food Waste in Norway 2010–2015, Final Report from the ForMat Project*; Ostfold Research Research Reports, OR.17.16; Østfoldforskning: Fredrikstad, Norway, 2016.
6. Koivupuro, H.-K.; Hartikainen, H.; Silvernoinen, K.; Katajajuuri, J.-M.; Heikintalo, N.; Reinikainen, A.; Jalkanen, L. Influence of socio-demographical, behavioural, and attitudinal factors on the amount of avoidable food waste generated in the Finnish household. *Int. J. Consum. Stud.* **2012**. [[CrossRef](#)]
7. De Hooge, I.E.; Oostindjer, M.; Aschemann-Witzel, J.; Normann, A.; Loose, S.M.; Almlı, V.L. This Apple Is Too Ugly for Me!: Consumer Preferences for Suboptimal Food Products in the Supermarket and at Home. *Food Qual. Prefer.* **2017**, *56*, 80–92. [[CrossRef](#)]
8. Hanssen, O.J.; Syversen, F.; Sto, E. Edible food waste from Norwegian households—Detailed food waste composition analyses from two different regions in Norway. *Resour. Conserv. Recycl.* **2016**, *109*, 146–154. [[CrossRef](#)]
9. Brancoli, P.; Rousta, K.; Bolton, K. Life cycle assessment of supermarket foodwaste. *Resour. Conserv. Recycl.* **2017**, *118*, 39–46. [[CrossRef](#)]
10. Hanssen, O.J.; Møller, H.; Svanes, E.; Schakenda, V. Life Cycle Assessment as a tool in food waste reduction and packaging optimization—Packaging innovation and optimization in a life cycle perspective. In *Life Cycle Assessment*; Schrivener Publishing: Curran, MA, USA, 2012; Chapter 16.

11. Van Geffen, L.E.J.; van Herpen, E.; van Trijp, J.C.M. *Causes & Determinants of Consumers Food Waste. Project Report*; EU Horizon 2020 REFRESH; Wageningen University and Research: Wageningen, The Netherlands, 2016; 44p.
12. Hanssen, O.J.; Stensgård, A. Home Edible Food Waste: Nordic Aspects. In *Handbook of Famine, Starvation, and Nutrient Deprivation: From Biology to Policy*; Preedy, V.R., Patel, V.B., Eds.; Springer Nature Publications: Heidelberg, Germany, 2018; Chapter 19.
13. Kantor, L.S.; Lipton, K.; Manchester, A.; Oliveira, V. Estimating and addressing America's food losses. *Food Rev.* **1997**, *20*, 2–12.
14. Williams, H.; Wikström, F. Environmental Impact of Packaging and Food Losses in a Life Cycle Perspective: A Comparative Analysis of Five Food Items. *J. Clean. Prod.* **2011**, *19*, 43–48. [[CrossRef](#)]
15. Hanssen, O.J.; Østergaard, S.; Svanes, E. Food waste prevention through improved packaging and distribution in the fresh bakery sector. In Proceedings of the IAPRI World Conference, Valencia, Spain, 8–11 June 2015.



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