

Review

Consumer-Related Food Waste: Causes and Potential for Action

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Abstract: In the past decade, food waste has received increased attention on both academic and societal levels. As a cause of negative economic, environmental and social effects, food waste is considered to be one of the sustainability issues that needs to be addressed. In developed countries, consumers are one of the biggest sources of food waste. To successfully reduce consumer-related food waste, it is necessary to have a clear understanding of the factors influencing food waste-related consumer perceptions and behaviors. The present paper presents the results of a literature review and expert interviews on factors causing consumer-related food waste in households and supply chains. Results show that consumers' motivation to avoid food waste, their management skills of food provisioning and food handling and their trade-offs between priorities have an extensive influence on their food waste behaviors. We identify actions that governments, societal stakeholders and retailers can undertake to reduce consumer-related food waste, highlighting that synergistic actions between all parties are most promising. Further research should focus on exploring specific food waste contexts and interactions more in-depth. Experiments and interventions in particular can contribute to a shift from analysis to solutions.

Keywords: food waste; consumer behavior; household; retail; suboptimal food; leftovers; literature review; expert interview; date labelling; pricing

1. Introduction

Food waste has received increasing attention over the past few years. In the EU, food is defined as something “...intended to be, or reasonably expected to be ingested by humans” ([1], Article 2). It is increasingly acknowledged that when food is not used to this end, but for other purposes within the waste hierarchy [2], the food itself and the resources exploited in its production, transportation or disposal are used inefficiently. This has unfavorable environmental, economic and social consequences on the sustainability of the food sector. The food sector is assessed to cause approximately a third of all greenhouse gas emissions (in the EU [3]). In 2009, Rockström *et al.* assessed which planetary systems are very close to or already past a biophysical threshold [4]. While the public is aware of the risks due to climate change and biodiversity loss, the similarly problematic imbalances in the nitrogen and phosphorous cycle [5,6] have hardly been discussed yet. However, all of these four planetary systems are strained by agricultural and food production in particular, which is why a more resource-efficient food production is crucially important. Moreover, food waste strikes many consumers and stakeholders as an inequitable and unjust “luxury” that humanity cannot afford in light of our challenge to provide food for more people with less and more stressed resources. Reducing this waste is accordingly listed as one of the necessary actions for more sustainable food security [7,8].

Overall, food waste can be defined as “...any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)”[9] (p. 6). In this definition, food waste also encompasses food used for animal feed (please see the “Fusions definitional framework” [9] for a detailed flow chart of resource flows in the supply chain and the types of foods removed from the chain). While food losses at the early stages of the supply chain are a problem in developing countries, food surplus and wastage at the later stages are primarily observed in developed countries [10–12]. The consumer role within the issue of food waste is thus especially crucial in developed countries. There are indications that the household food waste problem might be increasing (in the EU between 2004 and 2010, [13]), although more recent data also suggest that, with specific actions, a downward development is possible. For example, a decrease in food waste by 21% was seen in the U.K. between 2007 and 2012 [14], and 19% of Danish respondents self-reported that they waste considerably less food than before [15]. In these countries, organizations and activists claim that the societal debate and the actions undertaken have already had a positive impact. Yet, consumers do not only play a crucial role in food waste via their own household and in-store choices. Their actual or anticipated food perceptions and food purchase behaviors influence stakeholder decision making along the whole supply chain [16]. For example, retailers apply aesthetic standards to accept or reject foods based on the assumption that consumers will only buy foods fulfilling these standards.

We call food products that are wasted at the consumer level even though they are edible “suboptimal foods”, defined as foods that consumers perceive as relatively undesirable as compared to otherwise

similar foods because they either: (1) are close to, at or beyond the best-before date; or (2) deviate (visually or in other sensory perception) from what is regarded as optimal (usually equal to what is perceived as “normal”). This can be in the “buy/do not buy” choice situation in the store or in the “consume/do not consume” choice situation in the household. Suboptimal food encompasses foods that cause the largest amount of food waste (for example, approximately half of the food thrown away in households in the U.K. was “not used in time” [14]), as well as the food categories with the highest unfavorable sustainability-related impact (for example, wastage of dairy products and fresh fruit and vegetable in the EU causes high demands on land usage; [17]). Together with food scraps and leftovers, these categories constitute consumer-related food waste. It is not possible to give an exact number of the amount of waste according to this differentiation, but there is some often-cited data that can provide an idea of the relation between in-store and at-home food wastage: For example, FAO data assessed that in Europe, consumption stage-related food waste accounted for around 35% of all food wasted, while the share of food waste is close to 10% at the distribution stage [9]. A study conducted by LEI for the European Commission suggested that 31% of food waste across the supply chain occurs in households, and 14% of waste in trade and catering [17].

In order to reduce consumer-related food waste in developed countries, it is necessary to have an in-depth understanding of the factors shaping food waste-related consumer perception and behavior, both in the household as well as at the point of purchase. In the past few years, an increasing number of studies have examined food waste and consumer behavior, which calls for an inspection of the state of research in order to better target future research. To this aim, the current article reports the results of a literature review. Given that much research, as well as experiences from initiatives are not (yet) reported in academic research and that experts can assess the relative importance and research gaps, the literature review is coupled with an expert interview study. The contribution of this article is to provide a holistic picture of the factors causing consumer-related food waste, identifying potential action points for further reduction and highlighting future research directions with regard to consumer perception and behavior at the consumer level and in the consumer-retailer interaction.

2. Materials and Methods

2.1. Literature Review

For the literature review, we searched the databases Science Direct, Business Source Complete, and Web of Science using search terms “food waste” and “consumer”, in the title, abstract and keywords. Furthermore, we consulted the references of relevant articles that we found. We applied the following criteria for inclusion in the review: Firstly, we chose peer-reviewed research articles on consumer behavior regarding food waste that were related to food provisioning, handling, preparation and eating by individuals or households or reviews of this kind of research. Secondly, we focused on research published between 2000 and 2014. Thirdly, only English language research was considered. Research on the food service context was also included, because it might be potentially applied to household situations. In addition, food waste disposal behavior research, for example on recycling, was included, as it might reflect the factors of relevance to consumer food wastage.

In total, this resulted in 30 articles. Of these, 22 were published after 2010, and 14 had been conducted in the U.S. or the U.K. Six were on food service research questions—of these four from the U.S., mostly using experiments—while nine looked at household management and practices more holistically, with mainly qualitative and ethnographic research approaches. A further six articles focused on food provisioning issues or date labelling and five on disposal; the remainder generally exploring storage, packaging or consumer characteristics.

Given that much recent research on consumers and food waste has not yet been published academically and because the goal was to gain a holistic overview of the relevant factors influencing consumers, we also included consumer research reports on food waste and articles providing a review of a specific food waste issue in the supply chain or an overview of the food waste topic overall. The reports and articles were included as long as they provided information on factors at the consumer level, were published after 2010 and provided a perspective otherwise not yet covered by peer-reviewed articles. This resulted in a further 27 reports and articles.

The sources were divided between the authors, each of whom wrote a short description of the source and the main findings and characterization for each (see the supplementary file for a complete list and short descriptions of the sources and the main factors influencing food waste).

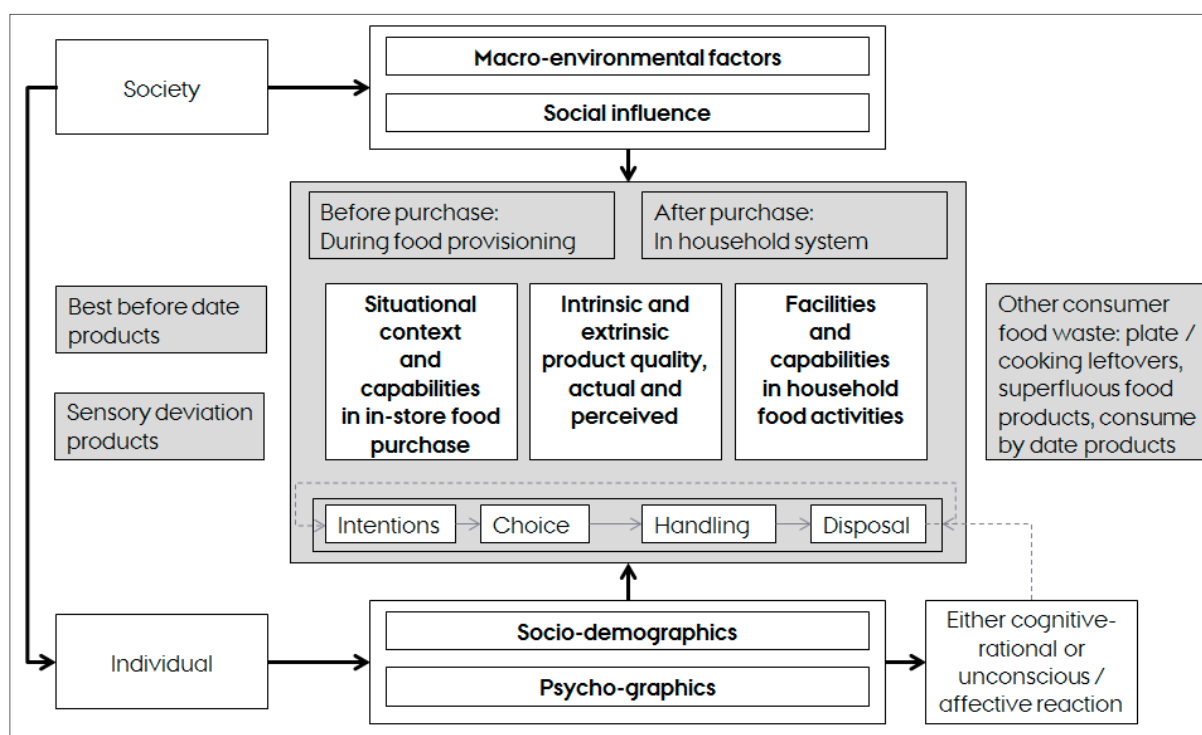
2.2. Expert Interviews

For the expert interviews, we contacted persons who were regarded as experts in the area of food waste and/or consumer behavior based on their work in the field and knowledge of the research. These persons included specialists from non-governmental organizations (NGOs), policy, journalism and academia. No representative from within the food supply chain itself was contacted, because the goal was to generate a broad overview of the consumer level and the consumer-retailer interaction food waste behavior. Seventeen persons were contacted, and 11 agreed to participate in an interview. Four of these experts were academics working mostly in research; three were from NGOs; three were policy makers; and two were journalists (some of them filled more than one role, e.g., journalist, as well as NGO, or journalist, as well as academic). A semi-structured interview guide was used, and the interviews were either conducted face-to-face, via phone or Skype. All interviews were transcribed verbatim and translated into English where needed (see Table 1). The experts were asked the following questions: (1) What do you think is the greatest cause of food waste at the consumer stage? (2) Where lays the best and easiest potential for reducing food waste at the consumer stage? (3) What do you think is the greatest cause of consumers perceiving products as suboptimal to buy in-store (to consume at home)? (4) Where lays the best and easiest potential for changing this perception?

In order to develop a holistic image of the factors influencing consumer-related food waste, as well as perception and behavior towards “suboptimal” food, the authors met for a brainstorming and clustering exercise of factors of influence, which was conducted after a first period of reading literature and before interviewing the experts. Based on this exercise and in consideration of (food-related) consumer behavior or household models [18–22], a model of the potential relations was developed and used as a point of departure in the interviews. It was finalized after completion of the literature review and the expert interviews (see Figure 1).

Table 1. List of the experts interviewed on food waste factors and potential to change.

| No. | Name | Role, country |
|-----|------------------|--|
| 1 | John Thøgersen | Professor in economic psychology and head of marketing and sustainability research group, Aarhus University, Denmark |
| 2 | Tara Garnett | Food Climate Research Network, University of Oxford, U.K. |
| 3 | Selina Juul | Founder of Stop Wasting Food movement Denmark (Stop Spild Af Mad), Denmark |
| 4 | Tristram Stuart | Founder, author and campaigner, U.K. |
| 5 | Silvia Gaiani | Consultant, researcher at the department of economics and agricultural engineering, University of Bologna, Italy |
| 6 | Mattias Eriksson | Swedish University of Agriculture Sciences, Sweden |
| 7 | Ulrika Franke | Coordinator of a Nordic food waste in primary production project, Swedish Board of Agriculture, Sweden |
| 8 | Anonymous | WRAP (Waste & Resources Action Programme), U.K. |
| 9 | Corne van Dooren | Voedingscentrum (food information center), The Netherlands |
| 10 | Chantal Engelen | NGO “Kromkommer.com”, The Netherlands |
| 11 | Yuca Waarts | LEI Wageningen UR, The Netherlands |

**Figure 1.** Model of the factors of influence on consumer-related food waste.

3. Results

The results are structured as follows. Firstly, we report on the findings from empirical research studies examining consumer behavior regarding food waste. The studies were categorized according to the main issue in focus (marked in *italics*) and described in the sequence that these occur between purchase in the store and disposal at the household, with the overall management of the whole process named last. Secondly, we report on findings extracted from the selected recent food waste reviews, overview articles

and reports, categorized as (marked in italics) further consumer-related factors extracted from these sources, findings on the consumer-supply chain-relation and recommendations for action. Third and lastly, we present the findings from the expert interview study, with regard to factors of influence on the one hand and potential for action on the other. The factors, as well as the actions are marked in bold, and we comment on which factors or actions emerged from the expert interviews in particular.

3.1. Consumer Behavior Research Regarding Food Waste

Regarding consumer *food provisioning* in terms of purchasing, a U.S. experiment found that consumers show little tolerance for visual imperfections, but those with higher environmental concerns are more tolerant. Consumers in general are willing to pay less for foods with visual imperfections compared to optimal foods, and this tendency is even stronger for organic foods compared to conventional foods [23]. A South African survey study shows that the influence of “status consciousness” (the perceived need to signal status via products, for example by displaying a large offer to guests) on fresh produce purchase behavior might be higher for low income/education consumers [24]. In a Dutch survey of bread customers, a high willingness to substitute by purchasing an alternative was found when items were out of stock in supermarkets. However, this finding was considered to be very category specific [25].

In terms of different *date labelling*, checking expiration dates appears to depend on the food category. Consumers check expiration dates frequently for products in which a decrease in quality is risked and for products with which they have experience of usage (as measured by the household consumption rate for the category). Relatedly, the willingness to pay for a perishable product decreases throughout its shelf life. This happens especially quickly when the quality of the product is affected by the process. Interestingly, WTP is higher in situations in which consumers plan to stop the aging process (for example, by cooking the product right away or freezing it) [26]. When consumers perceive dates on foods as an indicator of freshness and much less as a healthiness or safety indicator, consumers are willing to pay more for the food [27]. Indeed, studies have indicated that the proper use of “use by” and “best before” dates is not sufficiently understood by consumers. Consumers also tend to interpret these dates differently depending on the food category [28].

Findings on consumer behavior in *food service* environments indicate that changes in the food offered (introducing vegetarian meals) can lead to increased food waste for a period of time [29]. Similarly, changes in the mode of delivery (pre-order of food instead of ordering on the spot) might entail a similar trade-off (in that case, of meals being healthier when ordered in advance, but more of it wasted, possibly because the pupil’s wants had changed towards less healthy food by the time lunch is served [30]). However, research in food service environments has also shown that various “nudges” can reduce waste. For example, switching to a tray-less system [31], reducing plate size [32,33] and welcoming repeated helpings [32]. Moreover, the mere communication of a restaurant’s intent to reduce food waste has been shown to trigger consumers to waste less food [34].

Studies focusing on consumer *household storage* behavior highlight that many consumers keep a stock of potentially never used items that were bought for a special recipe or for a special occasion that has never occurred. These items are at some point thrown out [35]. Consumers have at least some knowledge on how to manage food in their households, but they often do not act in line with their

knowledge. For instance, they maintain the refrigerator temperature usually too high, store vegetables incorrectly, keep leftovers for too long and use date labelling to assess disposal even if it no longer applies after opening. Moreover, the way consumers handle foods often differs between food categories, not necessarily according to what would be the right handling for the best preservation of the food [36].

A Swedish household diary study looked at the influence of *food packaging* on the quantity and type of food waste. It appeared that 20%–25% of food was wasted due to packaging factors, such as packages being too large, packages being difficult to empty and best-before dates having passed. Households having previously participated in an environmental education intervention had more negative attitudes towards packaging (even though they acknowledged its role for food waste reduction) and wasted less [19]. A mixed-methods study in the U.K. found that, in general, consumers do not make optimal use of packaging functions or the information provided on it, and they are not aware of how packaging might prolong the product's lifetime at home [37].

From the research on consumer behavior in the food disposal area, it can be deduced that personal attitude crucially influences the intention to recycle food waste [38]. The institutional context can influence these personal attitudes and behavior with regard to food waste systems, with citizens trusting the local authorities and feeling positive about the respective system installed in their municipality [39]. A number of intervention studies have been conducted. These highlight that a door-to-door information campaign can lead to an increase of the source-separation ratio of food waste, while the ratio of incorrectly-sorted material decreases [40]. Furthermore, installing sorting equipment (for example, a metal hanger and a vessel for paper bags used for separate collection of food waste [41]) might be especially effective, because such equipment can function as a signal of a social norm or “visual nudge”/reminder [41]. Installing “bin cams” in households and subsequently sharing photos of waste in social networks can raise awareness and self-reflection. This, in turn, might generate feelings of shame and a realization of the attitude-behavior gap [42]. Household diaries in the U.K., combined with compositional analysis of household food waste, have looked at the reasons for food disposal. They find the most frequently-mentioned reasons for wasting food are that it could not be used in time, that too much had been prepared or served and that personal preferences, e.g., dislike of taste, trigger the decision to dispose of a food [43].

Research exploring the households' food and *food waste behavior or practices* can show a more in-depth picture of consumer perceptions and thoughts, both with regard to motives governing these, as well as behaviors as such. Evans concludes on ethnographic studies in the U.K. that consumers do not carelessly waste food [44,45]; rather, it is the socially-determined practices in food and eating and the contextual factors in which food habits are embedded that crucially impact consumer's wastage of food. Watson and Meah found that consumers seem to rarely explicitly articulate environmental concerns, but are strongly driven by an innate ethical motivation to do the “right thing” and to be thrifty, even enjoying thriftiness *per se* [46]. Yet, consumers also express *motives* that counteract food waste avoidance behaviors. For example, consumers experience the inconvenience connected to avoiding food waste and have the wish to be a “good” food provider for the family (ensuring all member's wishes and tastes are satisfied, potentially on the expense of cooking too much, allowing pickiness or throwing undesired leftovers out; [47]). The latter emerges similarly in terms of the family sacrifice connected to the usage of leftovers: it requires a certain family culture of accepting and being used to being served remains [48]. Furthermore, consumers make trade-offs between different goals, especially anxiety about the safety of

food *versus* concern about food wastage [46,49]. Consumers thus weigh priorities on waste avoidance for the sake of the environment *versus* safety for oneself and immediate others.

Moreover, household *food management* knowledge and capabilities seem crucial. Consumers' food waste behaviors are directly related to planning and shopping routines [50], having or lacking an overview of stocks, having or lacking knowledge about whether food can still be used and situational influences (e.g., specific purchase or consumption contexts; [51]). A diary study in Finland identified that gender, household composition, belief in packaging and perception of the "value of money" at purchase influence food waste [52], while it was mainly young, male and single consumers in research in Portugal [53] that wasted more food.

3.2. Consumer-Related Factors Discussed in Recent Food Waste Reviews, Overview Articles and Reports

After gathering nearly 300 factors on food waste in general, the EU project Fusions concluded that there were three general *consumer-related factors*: social factors, such as household type, family stage and related lifestyles, individual behaviors and perceptions of and expectations towards foods, and consumers' lack of awareness, knowledge and skills [54]. WRAP's "people focus" literature review in the U.K. found that household composition and household members' age, whether the household is a "home composter", availability of time for food-related activities, individuals' fussy eating and perceptions of their own food waste behavior are crucial factors influencing food waste. A European Parliamentary Research Report highlights that the societal trends of urbanization and changes in the composition of diets, as well as the overall consumer culture, are relevant causes [55]. Pointing in a similar direction as the latter report, lack of awareness, attitudes or preferences are described as consumer-level causes of food waste in the EC's "preparatory study on food waste" from 2010 that reviewed literature and facts [56].

Quested *et al.*, in an overview of WRAP's experience with the food waste issue, stress that wasting food is not a conscious decision. Commonly, there is a gap between the activity causing it and the consequence of wasting food. While food and eating is characterized by a complexity of habits and rituals, the wastage of food is largely invisible and, thus, much less impacted by social norms or social signaling. Further, there are great generational differences in food waste behaviors. For example, consumers having experienced scarcity during or after the Second World War hardly waste food [57]. However, Gjerres and Gaiani explain that consumers or citizens show a very 'strong reaction to food waste' with an intuitive feeling that it is wrong. They discuss the ethical implications and argue that the human view and perception of the role of food (preferably a gift rather than a product) would be crucial to reduce food waste [58]. Quested's point about the generational difference also underlines the importance of taking into account how historical developments have shaped today's food wastage behavior in the society overall. Changes evolving over time can also be highlighted for the concrete example of date labelling [59,60]. In sum, the macro-environmental context and developments should be taken into account when analyzing consumer-related food waste.

An important specific issue in the *consumer-supply chain interaction* is date labelling. Its terminology and applications vary widely, and this might contribute to consumers' misunderstanding [61]. Furthermore, retailers influence consumers by their pricing strategy for foods (price promotions, price

per unit when comparing various package sizes) [62]. Both retailers and producers impact consumers' choices by their packaging decisions for the food products, including whether and which information is displayed in terms of date labelling, information on storage and freezing [61,62] and the packaging functions [63].

In terms of *recommendations for actions*, it is argued that the focus should be shifted towards eating the food instead of discussing the wastage of it [57]. Valuable resources might be recovered at various stages of the food supply chain [64], and there are suggestions of how to tackle food waste at each of these stages [65,66]. Overall, however, it is argued that it is more important to prevent than to recycle food waste [67]. The food waste hierarchy provides a guidance structure to this end [2].

Furthermore, a more homogenous system for date labelling would be favorable [61,68], including a decrease of those date labels that are commonly misunderstood (e.g., “sell by” or “display by”, [62]) by consumers. This ought to be combined with educating consumers about the meaning of date labelling, the importance of limited shelf life and temperature control and safe handling methods [61]. It appears that the majority of foods are suitable for freezing and that doing so is better in terms of emission than discarding [69]. In the U.K., retailer voluntary actions that WRAP had recommended as favorable for food waste reduction have been introduced in most retail chains. Many of these actions refer to date labelling, on-package information or the area of pricing (e.g., price gradient of food in various unit sizes). Yet, little change had been observed in terms of pricing [62]. More than just environmental benefits should be discussed in communication, that is both the environmental, as well as the cost-saving benefits [57].

The increase in packaging waste is assessed to be a “lesser evil” than food waste, given that the food production stage appears to be of greater environmental impact than the additional resources used for packaging. Thus, it is suggested that packaging functions that help avoid food waste can favorably improve the sustainability of the food chain [70]. The negative environmental impact associated with food waste is in most cases not taken into account in an LCA analysis of alternative packaging, which in that case, might be misleading and indicate food waste-prone packaging as a favorable alternative [63].

Interestingly, contrary to concerns, it was not found that the implementation of food waste collection might lead to consumers causing more food waste in a kind of “rebound effect” (that is, a policy implemented against food waste not leading to the desired result or even backfiring by causing the contrary to happen) [71]. In terms of trade-offs between various sustainability issues regarding food, it was found that from four consumer behavior changes that can crucially reduce GHG emissions, one is a reduction of waste (two are related to meat consumption, and another is avoidance of air freight) [72].

3.3. Experts Views on Major Factors and Potential for Action

3.3.1. Major Factors

When asked about the major causes of food waste, experts elaborated on a number of factors that mirrored findings of the literature review, but they also discussed further aspects to these findings and raised new points. Overall, several experts stressed that there are clearly multiple causes involved and that these differ both for product categories and individuals.

At the individual consumer level, most experts especially stressed that the *lack of planning and management* of purchase, storage, preparation and reuse of food and meals is at the heart of the problem.

It is rooted in constraints of time and little priority given to food waste reduction behaviors, but also a lack of knowledge and know-how in storage and cooking. Coupled with a *culture of consumerism and abundance* and a generally *low price level of food*, this means that consumers tend to buy too much food and care too little about the risk of wastage in the subsequent steps to act in a way that avoids food waste.

At the point of purchase, it was frequently mentioned that consumers use *appearance as an extrinsic cue* that they can assess in order to estimate the level of intrinsic product quality. As a consequence, they quite rationally choose the seemingly more attractive product. Interestingly, though, one expert mentioned that appearance might potentially be overrated in the discussion on food waste. As a further crucial factor in the purchase situation, the overarching *consumer price orientation* and thus search for the optimal price-quality relation is a leading factor in food purchase. The latter also explains potential over-purchase in reaction to pricing (volume discounts and price gradients).

Several experts elaborated in particular on consumers' confusion about and misinterpretation of the *date labelling* they might be faced with on products. Here, the lack of priority given to avoiding food waste and, thus, the *trade-offs* consumers make in relation to other drivers of food-related behaviors come into play when consumers dispose of a product rather than risk any perceived health risk rooted in *food safety concerns*. The perceived risk level is increased in scale by a lack of knowledge about real and assumed food safety risks. As a further trade-off especially underlined by the experts, consumers or their household members might simply *dislike* eating the same meal or any leftover food or they may even feel a certain *disgust* at the thought of storing or eating leftovers. The latter, in light of the low priority of avoiding food waste, leads to disposal. An interesting further aspect was that when a food does not *taste* good enough, it might be wasted. Similarly, if consumers seek variation or new experiences in food, but it does not turn out to match expectations, this would also likely lead to disposal.

Generally, it was remarked that *consumer perceptions and habits* are crucially shaped by their upbringing, the social and cultural background and what they have been taught to expect in the food market environment that they face. This means that consumers tend to expect high levels of perfection in appearance and freshness in modern supermarkets. Conducting more than just mere adjustments of these deeply-ingrained perceptions and habits requires a considerably higher involvement with food waste avoidance on the part of consumers. It seemed that cultural differences in different regions of the same country might mean that major causes of food waste can differ greatly with diverse lifestyles of the consumers in these regions. Interestingly, a *lack of connection between consumers and the production* of food and agricultural raw materials was suspected by one expert, with the effect that consumers have difficulty visualizing growth and production. Consumers thus might lack an understanding of variation in appearance or lack proper valuation of the food.

In the consumer-retailer interaction, producer or retailer choices for the *packaging* sizes and functions were mentioned, as well as the type and length of the *date labelling* displayed. It was mentioned that not only cosmetic or marketing *standards*, but also nutritional standards might lead to greater food waste. Furthermore, the increase in citizens with allergies also triggers greater product differentiation, which again might lead to more wastage when all of these products need to be kept in store, but demand fluctuates. One expert also presumed food sector actors might *underestimate consumers' acceptance* of imperfection and would rather not take any risks. Another conceded there might also be rumors about, e.g., cosmetic or marketing standards that in fact no longer apply, but nevertheless impact supply chain

actor's decisions. Overall, the *macro-economic factors* of legislation and technology, but especially economic incentives or dis-incentives, cause oversupply, inefficiencies and food wastage.

3.3.2. Potential for Action

Asked about the potential to change consumer behavior and to change the factors impacting consumer-related food waste, experts elaborated on consumer-related, retailer-level and macro-environmental issues. With regard to the consumer, most experts mentioned *providing information* and knowledge to some extent, but also stated that there are constraints to providing information. For example, it would be necessary to repeatedly provide the information, since consumers tend to forget, and to deliver the information via various sources, as consumers differ as to which information source they rely on most. Information should also be in particular directed at consumers undergoing crucial life moments, which are known to entail changes in perceptions and habits. Understanding date labelling seemed an especially important issue, potentially easy to educate about, coupled with the alternative of encouraging and teaching consumers how to assess foods by looking, smelling and tasting. The latter action is also one element of *educating* consumers in 'food skills' in terms of assessing food and managing and planning food purchasing and handling. As a prerequisite, however, it requires *creating awareness* of the issue overall, as well raising individual's awareness of the fact that it happens in one's own household and not at other people's households only.

Moreover, consumers might be crucially influenced by their surroundings. This can be general *social norms* that they might learn from the debate in the media, the appearance of leftover cookbooks in bookstores or the restaurant waiter prompting whether they would like a doggy bag. Furthermore, these social norms are also transported among personal networks of friends, family or neighbors and then shape personal norms that individuals appropriate. This also speaks in favor of initiatives that allow signaling ethical statements through the purchase of products, for example products that are positioned and communicated as tackling food waste (e.g., produced with surplus food). Thus, actions that influence these norms to create the potential to signal behavior or to trigger peer influence can be successful directions.

With regard to retailers, a large number of suggestions were discussed, and it was argued that the current activities of retailers are both driven by increased efficiency (through increased sales or avoiding costly disposal), as well as fear of reputational damage, or seeking positive image effects or brand value. Interestingly, both in the U.K. and in Sweden, it was mentioned that there had been years in which the harvest of potatoes or apples respectively "failed" compared to the usual *standard of appearance* of the produce, but consumers bought them anyway; thus, normality seems rather relative and easy to shift. Therefore, retailers ought to relax cosmetic standards, also towards their suppliers and importers. Moreover, retailers, for their private label products or in interaction with producers, can work on *packaging* functions and related innovations, adapting packaging and sizes to the consumer group in question and increasing the shelf-life of foods.

Retailers ought not to "blame" the consumer for wastage in-store, but *incentivize the purchase of suboptimal food* by lowering prices or by selling it in separate classes. They might also reuse suboptimal food in-store by freezing or cooking before selling or else by delivering it to secondary retail. Furthermore, by cleverly marketing the suboptimal food and targeting the communication at respective

customer groups (communicating savings to one group, but ethical reasons to the other), retailers can make a crucial impact.

As overall macro-environmental factors, changes in the organization and phrasing of *date labelling*, e.g., at the legislative level, were suggested, but also *taxing of food waste* and potential changes that alter the *economic feasibility*. For example, it was frequently mentioned that a general trend towards scarcity in raw materials and, thus, *rising food prices* will have a decreasing influence on consumer food waste behavior.

Several experts stressed *synergy in the actions*, stating that actions work best when they are combined. For example, coupling the creation of attention and awareness with providing information and practical tips to consumers, while simultaneously working on altering consumers' food choice contexts that retailers and the food supply chain are shaping, might be very successful. A further point underlined was that the actions should be focused on *segmenting and targeting consumer groups*. Consumer segments differ in their motives to reduce food waste. Their characteristics or background therefore will predispose their behavioral responses or determine their abilities and priorities of concern.

4. Conclusions

4.1. Factors Causing Consumer-Related Food Waste

Food waste is clearly a complex issue, with a multitude of factors impacting food wastage or avoidance of such waste along the food supply chain from “farm to fork”, interacting in various directions. Nevertheless, we suggest that, based on the literature review and experts statements, it is possible to group and identify sociodemo- and psychographic factors of especially crucial relevance and that the research allows us to holistically visualize the factors at the consumer stage. We have graphically summarized these factors in Figure 1.

We conclude that socio-demographics as such do not play a major role in explaining food waste at the consumer level compared to psychographics. Probably the greatest direct connection to socio-demographics pertains to the *household composition in terms of age and number* of household members, given that it comes into play in multiple factors, which typically differ across household types. These are, for example, post-war upbringing of the older generation or greater food skills of older households, household size-dependent need for different food package sizes, higher food safety concerns or pickiness in households with children, lower degree of planning and higher likelihood of spontaneity and convenience orientation in younger or single households, *etc.*

More important, however, are the psychographic factors that predispose consumers' concerns, perception and behaviors in the store, as well as in their households. We suggest that these can be categorized as follows:

At the outset, a crucial factor is the degree to which consumers have the *motivation* to avoid food waste. While a share of food waste avoidance actions might be chosen in order to save money via “good housekeeping”, enacting the whole range of actions is rather due to ethical reasons related to fairness (e.g., in light of worldwide hunger), values or religious beliefs or environmental concerns. These ethical motives are then reflected in the consumers' varied beliefs about the issue and strength of attitudes towards food waste avoidance.

Furthermore, of special relevance are a number of factors related to awareness, knowledge and capabilities, which determine if, how and to what extent consumers can *manage food provisioning and handling* throughout the whole circle from planning the purchase, choosing foods, storing these, planning and preparing meals and organizing reuse or disposal.

Lastly, consumers *handle trade-offs and priorities* rather differently. Their handling of trade-offs depends on motivation and managing capabilities, as well as the presence of conflicting goals. The conflicting goals are rooted in further psychographic variables, such as health orientation, safety concerns, feelings of disgust, convenience orientation, or the wish to be spontaneous, hedonism and food enjoyment, the wish to be a good care-taker of the family, or skepticism towards packaging and respective technological innovations.

There are also *win-win-situations* to be mentioned: The first one is that economic constraints and price orientation traditionally, and to a renewed extent during the economic crisis, are drivers of food waste avoidance both in the store, as well as in the household. These drivers might also motivate alternative behaviors, such as sharing and gardening, or new developments, such as “freeganism”, or even “dumpster diving”. The alternative behaviors go further beyond mere financial considerations, in that the food waste avoidance practices might be part of a lifestyle and a consumer’s identity: consumers might take pride in being a smart shopper or thrifty household manager, enjoy the creative process of tackling leftovers or develop their identity via the formation of social relations in grass-roots networks.

Consumers’ motivation, managing capabilities and prioritization in light of the trade-offs mentioned above are impacted by the surrounding context. In closer proximity to the individual, this is the *food choice environment* of the store and the respective retailer’s choice of supply, marketing and communication. Furthermore, *social influences on food provision and handling* are crucial, such as family norms or habits, as well as culture- and society-specific appropriateness of foods and eating behaviors. Finally, the *macro-environmental context* is another context leading to, for example, date labelling regulation, safety standards, technological developments in food packaging and a household’s storage infrastructure, as well as the economic situation and overarching consumer culture in the society.

4.2. Potential Actions against Consumer-Related Food Waste

In the complex issue of food waste, a range of actions have been set into motion by stakeholders within the food chain or by actors trying to influence the way the supply chain is functioning. Due to the interactive nature of factors and according to the experts’ recommendations, it is clear that it is indeed only the combination of actions that can trigger change, and that there is no single solution. The prerequisite thereby seems that the combined actions work in good synergy.

Based on the literature review and experts’ statements, we can identify which actions seem to be of special importance to tackle, because there might be relatively greater potential for efficient changes: (1) date labelling; (2) expectations and perceptions; and (3) consumer household food management behavior.

Firstly, the issue of *date labelling* emerges rather centrally as an issue in consumer-related food waste. It appears that its legislation and food producer’s usage should be improved and harmonized to better match how consumers actually can handle date labelling, to then educate consumers consistently and repeatedly on its right understanding and usage. In the latter case, product package information, as well as retailer’s in-store communication efforts might be able to contribute.

Secondly, for products without date labelling or in some cases when the date has passed, it is crucial which *expectations and perceptions* consumers bring to their assessment of the food's acceptability. It appears that these can be further altered and shaped over time by actions, such as retailer's offering and actively marketing a broader range of diverse appearance characteristics in fresh produce. This can be coupled with a societal discussion fuelled by NGOs and campaigners triggering the consumers' reflection of the fact and consequences of standard appearances, leading to changes in societal norms in this regard.

Thirdly, improving *consumer household food management behavior* in terms of acquiring and actually enacting food skills and handling know-how to the end of avoiding food waste is a central issue. However, it is clear that it is not easy to change, especially in light of the many other goals and associated trade-offs involved in food and eating. Avoiding food waste might likely continue as a relatively low priority for consumers. Therefore, what appears to be a promising direction, especially as collaborations between multiple actors, is the combination of actions: on the one hand, providing actionable tips and tools, while on the other hand, slightly raising motivation and involvement by emphasizing the multiple ethical reasons alongside the win-win situations.

Suggestions where retailers come into play have already been mentioned, but further than that, we suggest that retailers ought to deepen their efforts in the following *retailer actions*: (1) pricing strategies; (2) packaging; and (3) exerting an influence up- and down-stream in the supply chain.

Firstly, retailers can further develop, test and evaluate different pricing strategies for "suboptimal" foods to strike a balance between satisfying consumers' desire of an optimal price-quality relation and reducing food waste. Consumers' desire for an optimal price-quality relationship can trigger unnecessary over-purchasing that only moves wastage from the store to the home. To avoid such behaviors, retailers might explore actions, such as different price levels for quality classes, price reduction for reduced storage life, price per piece or weight depending on category, matching unit size and price gradient with storage life, avoiding certain price promotions or developing variants that take food waste effects into account.

Secondly, retailers might further develop, adapt and communicate packaging size and functions (of their private label brands or cooperate with producers to that end). This entails deciding on packaging size in dependence of the product category and consumer group in question, or developing new functions for avoiding wastage in handling and storage or for determining the edibility of the food. Finally, retailers can also work towards reducing food waste upstream in the food supply chain by making use of their negotiation power and downstream by finding alternatives to disposal when foods cannot be sold (e.g., converting it into other products or passing it on to secondary retail, such as food banks).

4.3. Limitations to Tackling Consumer-Related Food Waste

As a limitation for action against consumer-related food waste, it has to be stressed that household food waste can only be expected to be efficiently minimized, but not abolished. A share of the consumer-related food waste needs to be tackled through actions upstream, that is at earlier stages in the supply chain. Furthermore, it has to be taken into account that food waste is, just as other food- and sustainability-related problems, a mere symptom of an unsustainable production and consumption system. This system is characterized by a focus on growth and resource extraction instead of reuse,

on materialistic orientation and consumerism, and it has led to low food prices (amongst others, due to the externalization of environmental costs caused by food production), a lack of a connection between consumers and the food they eat and a lack of appreciation of food as a vital source of life by consumers or food supply chain actors. Therefore, changing the causes rather than the mere symptoms needs to be considered.

4.4. Further Outlook

We can assert that the research on food waste has gained considerably in size in the past years. Further research should take a departure from these findings and include the variables identified as relevant. Moreover, future research should build on the previous research and, in particular, explore food waste consumer behavior in greater depth, by focusing on specific contexts, foods and segments. This should lead to results of even greater practical application and external validity. A further move from analyzing the current situation to experimenting with new approaches and solutions would be desirable as a next step, in particular by intervention studies, which so far are rather under-represented. With more in-depth studies of this kind, it ought to be possible to provide stakeholders with more accurate estimates about the relative effectiveness of different actions [73] that address the issue of food waste.

The research topic of food waste is an example of a very interlinked issue with various factors and consequences, typical for sustainability issues (such as, e.g., sustainable transport) in general and the food consumer area specifically (such as, e.g., healthy eating). Further research into consumers and food waste can contribute to the sharpening of consumer behavior theories and the application of these theories to sustainable consumption and the interactions observed in consumer's food wastage [74]. Applied studies might further promote the development of methods that allow exploration of behavior and identification of the underlying mechanisms.

Recent years have shown an increased focus on ethical issues in the food market sector and a number of respective food consumer trends. Public interest in the issue of food waste in particular has been very high. This can be partly explained by the strong intuitive feeling that it is not "right", the relative ease and thus appeal of some actions against it and the potential win-win situations to gain. We hope that the high interest can serve as a good entry point for consumers to become interested in food sustainability issues overall. For example, some authors mention ineffective food overconsumption and subsequent obesity-related health problems as a kind of food waste ("over-nutrition" [10]). Other instances are the pressing issue of resource-intensive foods that put an excessive strain on water resources and cause transport-related emissions or claim large shares of land usage (especially meat products [3,7,8]). We hope with this paper to contribute to the transformation to a more sustainable food system and to inspire more interesting future research on these sustainability issues.

4.5. Limitations of the Study

It has to be acknowledged that the number of persons interviewed is small (just exceeding the minimum recommended number of 10 [75] and below an ideal of 15 [76]) and that there are more persons known from the literature that could have served as experts. However, we think that the number of interviews was sufficient for the purpose of including an assessment of relative importance for action.

Moreover, while we provide some statistics on the amount of food waste at the trade/retail *versus* consumption stage in the Introduction, to our knowledge, there are no data that could further distinguish the food wastage categories we defined from a consumer perception point of view. The focus of the paper is on the identification of consumer behavior factors, rather than identifying the quantities of food wastage.

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Author Contributions

Jessica Aschemann-Witzel designed the research based on the joint project application and project group meeting discussion of which all authors but Marije Oostindjer specifically were a part. Ilona de Hooge, Pegah Amani and Jessica Aschemann-Witzel jointly conducted the major share of the literature review and the expert interviews, with a minor share of the literature review conducted by Tino Bech-Larsen. Jessica Aschemann-Witzel drafted the manuscript. All authors contributed references, comments and revisions, made substantive intellectual contributions to the scientific content and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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