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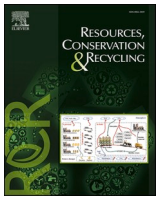

Full length article

Transforming waste into wellness: Enhancing well-being through domestic food upcycling

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ABSTRACT

This research focuses on a specific technique aimed at reducing household food waste: food upcycling, or the practice of creatively preparing new dishes (e.g., French toast) using leftovers (e.g., stale bread). We posit that engaging in domestic food upcycling activities not only helps reduce food waste but also enhances consumers' psychological well-being. We conducted three studies: a qualitative study ($N = 92$) aimed at providing initial insights into the association between domestic food upcycling and psychological well-being; a survey ($N = 100$) aimed at identifying the most prominent barriers to domestic food upcycling; and an experimental study ($N = 272$) aimed at assessing educational interventions designed to overcome the most prominent barriers identified in Study 2 and promote domestic food upcycling via perceptions of improved well-being. The results have important implications for both policymakers and the food industry.

1. Introduction

According to Eurostat (2023), households generate 54% of food waste, accounting for 70 kg per inhabitant, which is nearly twice the amount of food waste generated by the primary production and manufacture of food products and beverages. Meanwhile, more than 37 million people lack the means to afford a quality meal every other day (Eurostat, 2023). Given the magnitude of this issue, it is crucial to prioritize efforts aimed at reducing household food waste.

The key household behaviors contributing to food waste have been identified as poor home economics skills concerning the use of leftovers and the failure to plan meals (Parfitt et al., 2010; Porpino et al., 2015; WRAP, 2009). Among various alternatives for using leftovers, the food literature has highlighted an emerging option, namely *food upcycling*. Upcycled food are defined as foods that would have been discarded, but have instead been directed to higher uses (i.e., transformed into alternative food) with tangible benefits to the environment and society (Spratt et al., 2021). For example, stale bread that would usually be thrown away can be creatively processed and reused for other dishes, such as meatballs, French toast, or breading for other recipes. The preparation of upcycled foods is a creative, economical, and sustainable solution to curtail food waste.

As a creative activity undertaken directly by the consumer (Atakan et al., 2014) that helps close the consumption–recovery loop (Adıgüzel and Donato, 2021), upcycling can be considered a beneficial practice that contributes to household food waste reduction (Bocken et al., 2016; Luchs et al., 2021) that should be promoted among consumers for contributing to the household food waste reduction. In general, food consumption has been linked to both food and psychological well-being (Batat, 2020; Block et al., 2011; Bublitz et al., 2019; Mendini et al., 2019; Pizzetti et al., 2023; Scott and Vallen, 2019). Food well-being is defined as the "positive psychological, physical, emotional and social relationship with food at both the individual and societal levels" (Block et al., 2011, p. 6). It is a multidimensional construct associated with physical health, as well as the emotional, social, and spiritual aspects of food consumption (Ares et al., 2015; Jaeger et al., 2022). In addition to the pivotal role of health, the emotional aspects of food well-being are also positively related to life satisfaction and fulfillment (Jaeger et al., 2022). In other words, food consumption can contribute to psychological well-being (e.g., Batat et al., 2019; Donato and Monsurrò, 2024; Zarantonello et al., 2021), or the subjective experience of affirmative psychological states such as pleasure, life fulfillment, and a sense of purpose (Diener et al., 1999). Zarantonello et al. (2021) found that food-related activities, specifically intellectual, behavioral, affective,

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and sensory food experiences, positively affect psychological well-being.

Despite the link between food-related activities and psychological well-being, existing literature has not clarified whether sustainable food-related activities such as domestic food upcycling can contribute to consumers' psychological well-being. It is therefore unknown if the pursuit of well-being can serve as a primary motivation for convincing consumers to engage in domestic food upcycling to reduce domestic food waste. Consequently, the first objective of the present research is to explore the role of domestic food upcycling activities in enhancing consumers' psychological well-being. Moreover, given the main barriers to domestic food upcycling activity (see Aloysius et al. 2023 for a review), the second objective of the present research is to identify possible interventions that overcome the main barriers to domestic food upcycling and can leverage on psychological consumers' well-being to promote domestic food upcycling.

We employed a mixed-method research approach to address these objectives. In Study 1, we explored the relationship between domestic food upcycling and psychological well-being through a qualitative study. In Study 2, we identified the main barriers to domestic food upcycling and ranked them based on consumers' perceived relevance. Finally, in Study 3, we examined the effects of specific interventions designed to overcome the most prominent barriers to domestic food upcycling identified in Study 2 and assessed its perceived impact on well-being.

2. Conceptual background

2.1. Domestic food upcycling

Previous studies (e.g., Abdelradi, 2018; Aschemann-Witzel et al., 2018; Bhattacharya et al., 2021; Graham-Rowe et al., 2014; Reynolds et al., 2019; Romani et al., 2018) have proposed several interventions to prevent household food waste through planning routines, shopping habits, cooking skills, and overall food management behavior (Abeliotis et al., 2019). Examples include adequate preparation for grocery shopping, avoidance of impulsive purchases, and proper food storage to extend the durability of food or leftovers (Khorakian et al., 2024).

Another prevention behavior involves appropriately managing leftovers after preparing more food than is necessary for one meal to ensure that they are not wasted but instead consumed (Glanz, 2008). Leftovers nearing expiration can be creatively combined to prepare new dishes from scratch (Hebrok and Boks, 2017). This type of food upcycling (Zhang et al., 2021; Spratt et al., 2021) has been primarily analyzed in the commercial context (i.e., companies offering products that use ingredients close to the source of supply, such as carrot peels that are dried and used for powdered soups; Bhatt et al., 2020) or as a beneficial practice in producing pet food (Ye et al., 2022).

The social stigma of consuming discarded food may impede the acceptance of upcycled food products that use byproducts as ingredients (Edwards, 2021). Consequently, marketing and food studies have identified extrinsic cues that can positively influence intentions to consume upcycled products. These cues include product quality, benefits, and price (Aschemann-Witzel and Peschel, 2019; Grasso and Asioli, 2020); labeling and logos (Bhatt et al., 2021; Stelick et al., 2021); use of technology (Coderoni and Perito, 2020); and sociodemographic factors (e.g., generational cohort, gender, and education; Zhang et al., 2021). These studies, however, fail to acknowledge the role of food upcycling in domestic food preparation and consumption practices. The reuse of leftovers is a common domestic activity woven into our daily routines that serves several purposes. It contributes to reducing domestic food waste (i.e., environmental reasons), enables more efficient management of resources (i.e., convenience reasons), and offers the opportunity to engage in creative culinary experiences (i.e., creativity reasons). These three reasons—environment, convenience, and creativity—characterize upcycling activity across a variety of domains, from fashion and design (e.g., Adıgüzel and Donato, 2021) to food (Shi et al., 2022), and serve as the principal motivators for engaging in this activity (e.g., Sung et al., 2019; Wilson, 2016). Moreover, domestic food upcycling can be considered a caring practice that contributes not only to reducing household food waste but also to consumers' psychological well-being (Pizzetti et al., 2023). In fact, in their qualitative study, Shi et al. (2022) demonstrated that consumers' active engagement in upcycling is motivated not only by frugality or resource scarcity but also by a desire to shape their self-identity and improve their subjective well-being.

2.2. Food and psychological well-being

Psychological well-being has been studied in the context of sustainable practices (Luchs et al., 2021) as well as in relation to food consumption (Batat et al., 2019; Donato and Monsurrò, 2024; Mugel et al., 2019; Zarantonello et al., 2021). The seminal work of Block et al. (2011) contrasted the traditional perspective of "food as health" with a novel perspective of "food as well-being," emphasizing the positive contributions food consumption can make to consumer well-being. Subsequent research on food well-being revealed how food is often associated with hedonic goals, such as taste and positive emotional objectives (e.g., Donato and Monsurrò, 2024; Mugel et al., 2019), rather than functional goals, such as achieving health.

More importantly, Zarantonello et al. (2021) demonstrated that food-related activities result in positive consumer experiences and enhanced psychological well-being, particularly in terms of higher perceived life satisfaction, defined as an evaluation of one's quality of life based on individually chosen criteria (Diener et al.,1999). The link between behavioral food experience, namely how we eat food and what we do with it, and consumers' psychological well-being is of particular interest. In the present research, we embraced this perspective by considering domestic food upcycling as a sustainable behavioral food experience, and we explored whether this activity can also contribute to an individual psychological well-being.

The increased life satisfaction associated with food activities can be pursued through two different paths: a hedonic path focused on pleasure and a functional path focused on meaning (Zarantonello et al., 2021). These two paths are consistent with previous psychological studies suggesting consumer well-being can be achieved through either a hedonic route, involving pleasurable moments, or a rational route, by engaging in meaningful activities (Kahneman et al., 1999; Seligman, 2011; Waterman, 1993). The hedonic path equates happiness with pleasure, which can be related to the positive feelings and sensory experiences that arise from food preparation and consumption. In contrast, the rational path posits that true happiness emerges from engaging in meaningful activities. This may include food planning activities, such as deciding where to have dinner, selecting items from a restaurant menu, or even the simple act of opening the fridge at home to decide what to cook for dinner.

The present research aims to explore whether domestic food upcycling activity positively affects consumers' psychological well-being and how to support this activity. Aligning with the most recent research in the field (Zarantonello et al., 2021, 2023), we adopted a conceptualization of well-being as various interconnected components, such as happiness and life satisfaction, where both pleasure (i.e., the hedonic component) and meaning (i.e., the rational component) contribute to life satisfaction (psychological well-being). We adopted a positive perspective in pursuing these aims, in line with the recent development of research that extensively emphasizes the importance of a positive approach to sustainable consumption (Winterich et al., 2019; White et al., 2019), suggesting that optimistic messages, along with underlying positive feelings (e.g., Peter and Honea, 2012) can effectively motivate consumers toward more sustainable behavior. Consequently, we intentionally framed domestic food upcycling as pleasurable, creative (Adıgüzel and Donato, 2021), and capable of increasing well-being, intending to elicit positive experiences so that we could develop an in-depth understanding of the rationale behind the involvement in this activity.

Table 1
Theme description (Study 1).

Category (% of respondents)	Quotes from respondents
Well-being (58%)	*Participant #5. I recently found myself in a position where I have little time to prepare food. But I still require tasty and, most importantly, nutritious meals with a lot of veggies (I am vegan) so I bought a used slow cooker. It's been amazing! I started making stews with all the veggies I have in the fridge. I just chop them up, throw them into the slow cooker for a few hours along with a broth to give it some flavor, and I'm thus able to make a large quantity of nutritious stew full of veggies that will last me for days. Almost nothing in my fridge now goes to waste. I feel like I'm doing a good thing for the environment as well as providing myself with cheap, wholesome, nutritious food.* *Participant #18. I actively use all surplus food into new forms of food or what I can't use the birds and wildlife outside always enjoy food leftovers. Even when I've peeled potatoes, I wash the peelings and fry them in a deep fat fryer for the birds. They love them hung on the bird feeder and they are not there for very long. Any cooked veg left over from a Sunday dinner gets mixed into bubble and squeak, and is great to freeze. Nothing gets wasted in my home and it makes me feel good that I don't have wastage and if I do the birds and wildlife get to eat it.* *Participant #61. I have a vivid memory of a time when I found myself with various leftover vegetables, some cooked rice, and grilled chicken in the fridge. Instead of considering them as separate items, I decided to whip up a colorful fried rice dish. Chopping and sautéing the veggies filled the kitchen with a tantalizing aroma, creating a sense of anticipation. The sizzling sounds and the vibrant colors blending in the pan ignited my creativity. Adding a dash of soy sauce, a pinch of spices, and the leftover chicken transformed the simple ingredients into a flavorful symphony. The entire process felt like a spontaneous culinary adventure, and I couldn't help but revel in the accomplishment as the dish came together. Taking the first bite revealed a burst of flavors. The satisfaction wasn't just in the taste but in the realization that I had turned overlooked ingredients into a delightful meal. This experience left a lasting memory of resourcefulness and the joy of culinary experimentation. Recalling that episode now brings a warm sense of nostalgia and pride. It serves as a reminder that kitchen creativity not only minimizes food waste but also infuses unexpected joy into daily life. Sharing this experience with others feels like reliving the cheerful moments of that impromptu cooking session.*
Creativity (20%)	*Participant #4. I created a salad from the night before chicken katsu curry as I cooked too much of it. We created the breadcrumb from corncakes, which turned out to be so tasty. I don't like normal chicken on a salad and didn't have any panko breadcrumb so decided to use what I had in the dry store. Once we'd crunched up the corncakes, we put the chicken in batter then shallow fried them. These turned out amazing and made the salad so tasty. The corncakes weren't getting eaten either so I saved waste on them too as I was going to put them in the bin soon.* *Participant #55. I had some leftover roasted vegetables, a small container of cooked quinoa, a handful of spinach, and a half-empty jar of tomato sauce. I started by sautéing the leftover vegetables in a pan with olive oil, garlic, and a sprinkle of dried herbs. As the kitchen filled with the delightful aroma, I tossed in the cooked quinoa, letting it absorb the flavors. Next, I raided the spice cabinet and uncovered a forgotten jar of curry powder. I added a teaspoon of curry powder to the pan, stirring it in and letting the spices mingle with the vegetables and quinoa. To bind everything together, I remembered a nearly empty carton of eggs in the fridge. I beat a couple of them and poured them over the mixture, creating a cohesive and savory blend. As a finishing touch, I dolloped a spoonful of the half-used tomato sauce on top. I slid the improvised frittata into the oven.* *Participant #60. Since getting a toasty maker, I've discovered efficiency. It's incredible how simple it is to transform leftover ingredients into sandwiches. Not only does it save food from going to waste, but it also sparks my creativity in the kitchen. Experimenting with different combinations has become really fun. I've found that even odds and ends from various meals, like roasted veggies, bits of cheese, or sauces, can be repurposed into new sandwiches. It's become a go-to solution for those days when I'm unsure what to make for a quick, satisfying meal.*
Convenience (14%)	*Participant #3. The situation was one which was out of my control, I had no money left to buy anything and payday was a few days away. I used some bread out of the freezer with some cheese and various spices to make some rather excellent cheese on toast. I had never made it before, just came up with it on the spot because there was nothing else whereas normally I would have just ordered a takeaway and wasted money like that.* *Participant #15. When I can, I often use stale bread to make a bread-and-butter pudding. Often reduced bread in the supermarket is only 10p or so—but if I have half a loaf that I know is going off and won't get used, I will chop up the stale bread and combine it with a mixture of milk, sugar, and eggs that I'll have lurking in the back of my cupboard. I ideally want to add raisins and sprinkle brown sugar on the top but I rarely have these at my disposal. My flat mates will sometimes have brown sugar which can really elevate the bread-and-butter pudding.* Participant #30. So, my wife made a chicken stew for Christmas dinner. She defrosted and boiled 1kg of chicken on Christmas Eve with the intention of putting it in the slow cooker with the gravy overnight. However, in the evening we found out at the last minute that my mother and my wife's mum and dad would not be joining us on Christmas Day. This meant she had prepared far too much chicken. In the end, she only put half of it in the slow cooker with the gravy. Boxing Day morning I found the rest of the chicken still in the fridge. So I made up a pot of curry sauce and put the rest of the chicken in that. As we still had plenty chicken stew for Boxing Day lunch, I made the curry then portioned it out into tubs and put them in the freezer. I will use them for my dinner at work over the next week.
Healthy and tasty meal (5%)	*Participant #2. This is something I do very regularly because I aim to reduce my food waste as much as possible. I take the time to look at what I have and what needs to be used. I consider what I have eaten a lot of recently and what I plan to eat in the near future and make my decisions around that. Do I want to be healthy and build a complex salad of vegetables and proteins or do I want to mix everything today into a pasta bake smothered in cheese, delicious and nutritious in its own right. I let my heart and my stomach make the choices for me and often split the difference—something rich and fatty with something light and crunchy with the aim to use as much produce as possible.* *Participant #3. A relevant scenario actually applies to this very morning. From the Christmas dinner there was a lot of surplus vegetables in the fridge, it did not have much time left before it would become unusable. To use the extra veg, I decided to put it all in a stew pot along with some of the extra turkey and made a big stew for myself and my family. I often like to do this with food that is close to expiring. I hate to see good food go to waste just because there is something fresher available and with the extra care that goes into using up every last part of the food means that what is made is always very tasty and healthy.*
Others (3%)	*Participant #1. My friend once bought gochujang, which she used to make something for me while she was staying over and then left it at my house. I hadn't used it again for months but I recently tried a new recipe with it and it was very good, so now that I know how to use it I will be using it more often. I might even consider buying it again once I run out. I don't cook many Korean dishes but I might try more now, because I quite like the gochujang.* *Participant #85. I like to reuse some leftover chicken from time to time and make a curry. I sometimes feel cheap for doing so, I try not to reuse food too often as this diminishes the quality of the food itself. I would like to try to use the correct amount of food initially. I like to make myself a curry using all of the available ingredients I have to hand, usually using some ingredients I have spare in my fridge at home.*

3. Empirical research

3.1. Study 1: food upcycling and psychological well-being

3.1.1. Method

The objective of Study 1 was to obtain preliminary evidence of our assumption about the association between domestic upcycled food preparation and psychological well-being. We conducted a critical incident technique (CIT) survey (Flanagan, 1954; Romani et al., 2018) to uncover and interpret the specific situations related to domestic upcycled food. A total of 100 U.K. participants (M_{age} = 38.72, *SD* = 12.66; 56% females) recruited through Prolific took part in the study. Participants were first asked whether they usually manage domestic cooking and those who replied "no" (eight participants) were excluded from the study. The remaining 92 participants who reported managing domestic cooking were asked to describe, in as much detail as possible, a personal episode in which they had a pleasant experience related to the creative use or combination of leftover food (M_{age} = 38.55, *SD* = 12.77; 56.8% females).

Two coders independently categorized the responses to identify the underlying mechanisms that explain the pleasure felt by participants during the creative combination of food leftovers. In some instances,

participants provided multiple reasons for why domestic food upcycling was a pleasurable experience. The coders employed an inductive approach, allowing themes to emerge directly from the data without preconceived categories or a theoretical framework. Consequently, in the initial coding phase, we isolated concepts that predominantly surfaced from the reported answers. Discrepancies in coding were discussed by the coders to reach a consensus. In the first coding process, classification of responses resulted in five main categories, which are reported in Table 1 with frequencies and representative quotes from the participants. After identifying the principal positive motive consumers associate with domestic food upcycling, we conducted a second coding process to comprehensively analyze the presence of possible underlying motives (see Table 2).

3.1.2. Results

The results of the qualitative study revealed that domestic food upcycling is often considered a positive, pleasurable experience with several possible motives. Life satisfaction (i.e., "well-being") emerged as the most frequently reported motive associated with domestic food upcycling (58%). The creative process necessary to prepare new dishes using leftovers was another frequently reported cause (20%), followed by convenience factors, such as saving time and money (14%), and the enjoyment associated with a meal prepared with leftovers (i.e., "healthy and tasty meal"; 5%). A miscellaneous category (i.e., "others"; 3%) collected the residual motives.

The role of creativity and convenience in domestic food upcycling confirms previous findings, which suggest that these two elements, along with sustainability, are defining characteristics of upcycling (e.g., Adıgüzel and Donato, 2021). Happiness, life satisfaction, and, more generally, psychological well-being emerged as the primary outcomes associated with domestic food upcycling.

Analyzing the responses within "well-being" category, we found that, among the participants who associated domestic food upcycling preparation with positive feelings connected to life satisfaction, 58% attributed this satisfaction to hedonic elements (e.g., the emotional connections formed when preparing a meal with friends or relatives). We refer to this category as "hedonic well-being." The remaining 42% of the responses in the well-being category were associated with life satisfaction stemming from more rational activities (e.g., contributing to waste reduction and fostering a more sustainable environment). The differentiation between the hedonic and rational aspects of psychological well-being resulting from domestic food upcycling aligns with the abovementioned research by Zarantonello et al. (2021; 2023) that describes psychological well-being (i.e., life satisfaction) as influenced by two main factors: a rational component linked to meaning and a hedonic component linked to pleasure (see Table 2).

Table 2
Well-being themes description (Study 1).

Category (% of respondents)	Quotes from respondents
Hedonic well-being (58%)	*Participant #8. I had some leftover spaghetti Bolognese from the other night and my friend had some leftover tuna, cheese and crackers, so I used the spaghetti to make a paste to be embedded into the crackers, then I added some parsley and cumin and then I made some cheese sauce as I had some leftover flour and eggs. I felt inspired and motivated and I showed some to my friend and he liked it. Also, I was nervous and apprehensive as I was unsure whether it'd turn out good.* *Participant #14. I routinely use leftover vegetables at the end of the week to create delicious meals. In the past I've used these veg through making different styles of pizza or flatbreads or through use of making a breakfast hash. Using leftover food can challenge you as a chef, as you have to be quite creative. This can be quite nice though and throw out all the recipes and use what you have left. It can feel very rewarding taking old and leftover food to create a new delicious dish. It only requires some creativity, a little amount of effort and you can feed yourself.* *Participant #93. I really hate food waste so I grabbed all the spare veggies I had and some leftover chicken from a previous dinner that was in the fridge, chopped them all up and fried in some garlic and spices and hashed up a pasta sauce with some passata I had in the cupboard. Added pasta and then topped with cheese which I grilled to make it even tastier–really satisfying dinner made with leftovers that everyone in the family enjoyed.*
Rational well-being (42%)	*Participant #71. I make roasted Mediterranean veg occasionally when I have soft vegetables in the fridge. I use the peppers and tomatoes which are soft and some additional veg. I cook more ham, enough to have it for another meal the following day. It makes me happy that I am not wasting the food. I enjoy making fresh meals in the evening, then I reheat the food for lunch the following day so I am not wasting food.* *Participant #79. I had some spare minced meat and vegetables left over after making a Shepherd's pie, so I combined the ingredients with pasta the next day to make a pasta Bolognese dish for my daughter. I remember wrapping the extra veg in a plastic bag so it wouldn't spoil and locating the extra ingredients like an onion and herbs that I would put together with my leftover carrot and meat to complete the dish the next day. I fried up the onion and combined it with the mince. I was happy that I was able to use the food for my daughter instead of discarding it. I was glad I had enough pasta sauce to combine with the meat and added a tin of tomatoes to make the sauce go further. I was pleased that I discovered a use for my extra meat, which meant I could get value for money from my purchase instead of throwing it away and I would be able to repeat this meal option in the future.* *Participant #80. There was some cream in the fridge, it had already been opened and was a day past its expiry date. It smelled a bit sour, but not rancid. It would have been unsuitable to pour onto a dessert. Instead, I cooked some pasta, then mixed it with the cream with some dissolved chicken stock and herbs. This was very tasty. Normally I would consider this meal a bit unbalanced, but I could justify making it because the cream was soon to be unusable, so I felt better about eating something I would normally consider unhealthy due to the avoidance of waste.*

3.2. Study 2: identifying the main barriers to domestic food upcycling

3.2.1. Method

Building upon the findings of Study 1, Study 2 was a consumer survey conducted with the objective of examining the primary barriers to domestic food upcycling and prioritizing them to identify those that have the greatest impact on the behavior, in order to design effective interventions. A sample composed of 100 adult consumers from the U.K. were recruited through Prolific to complete an online survey hosted by Qualtrics.[1,2] Of the participants, 31% were men and the average age was 41.24 years (SD = 14.92; min = 18; max = 76). The average number of people in the respondents' households was 2.62 (SD = 1.20; min = 1; max = 5).

We selected a series of measures to shed light on consumers' perceived barriers to the adoption of the domestic food upcycling activity taken from the existing literature on domestic food waste and the main reasons underlying this behavior (e.g., Aloysius et al. 2023; Ananda et al., 2022; Visschers et al., 2016). We selected nine potential barriers for inclusion in the survey: 1) limited cooking skills, 2) limited awareness of food waste effects, 3) limited awareness of the financial costs of food waste, 4) perceptions of health and safety risks, 5) negative emotions associated with food waste, 6) social norms, 7) limited knowledge about storing leftovers, 8) perceptions of leftovers, and 9) limited knowledge of how technology can support food upcycling. Each barrier was measured with at least three items. Respondents were asked to evaluate each item related to the identified barriers to domestic food upcycling activities using a 7-point Likert scale (1 = strongly disagree, 7

[1] No respondents were excluded from the sample as no one failed the attention checks included in the questionnaire.

= strongly agree) (see Table I in Appendix A for measures, value means, the reliability indexes, and the correlations between barriers).

3.2.2. Results

All the barriers proved to be relevant as all the average scores were rated above 4 (see Appendix A, Table I). The strongest barriers to domestic food upcycling were limited cooking skills, limited awareness of food waste effects, negative emotions associated with food waste, and social norms, all of which had a mean value above 5. The weakest barrier was the limited knowledge of how technology can support food upcycling, with a mean value of about 4.

To identify the most prominent barriers to domestic food upcycling, we proceeded to statistically compare the barrier mean values. Table 3 reports the t-tests conducted for each pair of barriers. The most prominent barrier was limited cooking skills, as it had the greatest mean value (M = 5.68, SD = 0.98) and was statistically different from all other obstacles. Limited awareness of food waste effects (M = 5.01, SD = 1.34), negative emotions associated with food waste (M = 5.23, SD = 1.38), perceptions of leftover (M = 4.96, SD = 1.19), and social norms (M = 5.28, SD = 1.05) followed. These barriers did not differ in relevance as the results of the t-tests comparing each pair showed no statistical difference. A third group of obstacles was composed of perceptions of health and safety risks (M = 4.79, SD = 1.36), limited awareness of the financial costs of food waste (M = 4.81, SD = 1.34), and limited knowledge of how technology can support food upcycling (M = 4.52, SD = 1.50). Finally, the least relevant barrier was limited knowledge about storing leftovers (M = 4.05; SD = 1.35).

The study revealed that the primary hindrance to the adoption of domestic food upcycling is a lack of the cooking skills required for utilizing leftovers effectively. As a result, our subsequent investigation will concentrate on devising an intervention to enhance consumer cooking abilities. We also singled out the lack of awareness regarding the adverse effects of food waste as this barrier presents an opportunity for intervention through educational initiatives aimed at teaching consumers about the detrimental impacts of food waste and how they can be mitigated through home-based upcycling activities.

These two specific barriers were chosen for examination in our upcoming study due to their significance and the potential to address them through interventions of differing approaches—one focused on enhancing consumer skills and the other on augmenting consumer knowledge. By selecting these barriers, we aimed to assess the differential impacts of these educational interventions on consumer intentions to adopt domestic food upcycling practices and subsequently enhance psychological well-being.

3.3. Study 3: intervention study

3.3.1. Method

3.3.1.1. Participants and procedures. The objective of Study 3 was to identify and test effective interventions that increase the intentions of consumers to engage in domestic food upcycling behaviors through the pathway of increasing consumer well-being.

The findings of Study 2 guided the selection of educational interventions implemented in Study 3, which were specifically designed to address the most significant barriers to domestic food upcycling. Our attention was directed towards interventions aimed at raising awareness of the food waste problem and enhancing cooking skills with leftovers. We conducted a 3 × 1 between-subjects experiment, randomly assigning participants to one of three experimental scenarios. Scenario A was aimed at raising awareness of food waste, featuring a statement highlighting the issue of food waste and data meant to reinforce consumers' understanding of its negative effects. Participants in Scenario A were subsequently encouraged to engage in domestic food upcycling, such as utilizing leftover bread. Scenario B was aimed at increasing consumer skills in food upcycling, featuring the same statement highlighting the food-waste issue and the same encouragement to upcycle domestic food, plus a recipe for French toast using stale bread. Scenario C was a control group in which participants were only provided with the statement about food waste and the exhortation to upcycle domestic food. Detailed explanations of all three scenarios can be found in Appendix B.

Adult consumers in the U.K. were recruited through Prolific to complete online surveys hosted by Qualtrics and were randomly assigned to the scenarios described above. A total of 300 individuals participated in the survey, approximately 9% of whom were removed from the sample for failing the attention and manipulation checks.[2] The final sample consisted of 272 respondents randomly assigned to the groups: 93 were exposed to the stimulus manipulating awareness of the food waste issue (Scenario A), 90 to the stimulus manipulating cooking skills (Scenario B), and 89 were in the control group (Scenario C). Of retained participants, 30.1% were men and the average age was 41.25 years (SD = 13.12; min = 18; max = 77). The experimental groups did not vary in gender ($\chi^2(4) = 3.28$; $p = .51$) or age ($F(2, 269) = 1.26$, $p = .29$).

3.3.1.2. Measures. We followed Zarantonello et al. (2021, 2023) to measure well-being, positing that both the pleasure and meaning dimensions contribute to life satisfaction (i.e., perceived well-being). The respondents rated the level of well-being they experienced while imagining engaging in the encouraged food upcycling activity (pleasure: M = 4.57, SD = 1.57; meaning: M = 4.39, SD = 1.64; life satisfaction: M = 3.67, SD = 1.66). They also rated their intention to engage in the activity using three items adapted from Dodds et al. (1991) (M = 5.23, SD = 1.26). Respondents rated each item using a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). More information on these measures is presented in Table I in Appendix C.

An exploratory factor analysis (EFA) conducted on the main variables of the study demonstrated that the items loaded on four factors, as expected, with the loadings ranging from 0.88 to 0.96 for pleasure, 0.63 to 0.98 for meaning, 0.76 to 0.98 for life satisfaction, and 0.69 to 0.91 for intention to upcycle. We also conducted a confirmatory factor analysis (CFA) that considered the same focal variables of the model (LISREL; Jöreskog and Sörbom, 1996), which revealed a good model fit (Bagozzi and Yi, 2012; $\chi2(48) = 136.84$; CFI = .98; NNFI = .97; RMSEA = .08; SRMR = .04). All factor loadings were high and significant, confirming the convergent validity of the measures. The psychometric characteristics of the measures were assessed; all the standardized factor loadings in the model were high and significant: composite reliabilities (CR) were above .70, and the average variance extracted (AVE) greater than .50 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). The discriminant validity was also tested using Fornell and Larcker's (1981) criteria. Details are provided in Table II in Appendix C.

Respondents were also asked how frequently they buy and consume bread ($M_{\text{recipe stimulus}} = 5.11$, $M_{\text{awareness stimulus}} = 4.86$, $M_{\text{control group}} = 4.99$; $F(2, 269) = .54$, $p = .58$), reuse food leftovers ($M_{\text{recipe stimulus}} = 5.28$, $M_{\text{awareness stimulus}} = 5.41$, $M_{\text{control group}} = 5.39$; $F(2, 269) = .25$, $p = .78$), and reuse stale bread ($M_{\text{recipe stimulus}} = 3.37$, $M_{\text{awareness stimulus}} = 3.94$, $M_{\text{control group}} = 3.63$; $F(2, 269) = 2.02$, $p = .13$). As there was no statistical difference between the groups, it can be assumed that participant responses reflected the content and intent of the experimental manipulation rather than differences in extraneous stimuli characteristics. Finally, respondents also rated their environmental concern (M = 4.79, SD = 1.26), frugality (M = 5.63, SD = 1.02),

[2] At the end of the questionnaire, respondents were asked to recall the stimulus to which they were exposed: the scenario containing a recipe, the scenario containing details of the negative effects of food waste, the scenario exhorting them not to waste bread, or don't know/don't remember. We only retained respondents who correctly remembered the intervention to which they had been exposed.

Table 3
T-tests comparing barriers (Study 2).

	1	2	3	4	5	6	7	8	9
(1) Limited cooking skills	–								
(2) Limited awareness of food waste effects	t (99) = 4.53;p < 0.01	–							
(3) Limited awareness of the financial costs of food waste	t (99) = 5.10;p < 0.01	t (99) = 1.35;p = 0.18	–						
(4) Perceptions of health and safety risks	t (99) = 5.16;p < 0.01	t (99) = 1.13;p = 0.26	t (99) = 0.11;p = 0.91	–					
(5) Negative emotions associated with food waste	t (99) = 2.73;p < 0.01	t (99) = -1.51;p = 0.13	t (99) = -3.15;p < 0.01	t (99) = -2.46;p < 0.05	–				
(6) Social norms	t (99) = 3.26;p < 0.01	t (99) = -1.83;p = 0.07	t (99) = -2.99;p < 0.01	t (99) = -3.39;p < 0.01	t (99) = -0.33;p = 0.74	–			
(7) Limited knowledge about storing leftovers	t (99) = 10.25;p < 0.01	t (99) = 5.26;p < 0.01	t (99) = 4.63;p < 0.01	t (99) = 4.67;p < 0.01	t (99) = 6.49;p < 0.01	t (99) = 8.76;p < 0.01	–		
(8) Perceptions of leftovers	t (99) = 5.72;p < 0.01	t (99) = 0.24;p = 0.81	t (99) = -0.91;p = 0.37	t (99) = -1.25;p = 0.21	t (99) = 1.479;p = 0.15	t (99) = 2.70;p < 0.01	t (99) = -5.94;p < 0.01	–	
(9) Limited knowledge of how technology can support food upcycling	t (99) = 6.84;p < 0.01	t (99) = 2.46;p < 0.05	t (99) = 1.34;p = 0.18	t (99) = 1.58;p = 0.12	t (99) = 3.27;p < 0.01	t (99) = 4.62;p < 0.01	t (99) = -2.77;p < 0.01	t (99) = 2.54;p < 0.05	–

N = 100.

involvement in cooking activities (M = 5.31, SD = 1.36), and moral attitude (M = 2.19, SD = 1.30) to control for these personal characteristics in the analyses (see Appendix C; Table I).

3.3.2. Results

We performed a mediation analysis where meaning and pleasure served as parallel mediators of the manipulation's effect on life satisfaction, which subsequently influenced consumer intention to engage in the activity (PROCESS Model 80; Hayes, 2022). The proposed model is presented in Fig. 1. To strengthen the robustness of our results, we controlled for the possible effects of relevant individual characteristics (i.e., environmental concern, frugality, involvement in cooking activities, and moral attitude) and demographic characteristics (i.e., age, gender, number of household members).

Table 4 details the results of Study 3, which show that the recipe-based intervention (Scenario B) significantly affected pleasure (b = .64, p < .01; 95% CI = .23 to 1.05) but not meaning (b = −.19, p = .35). Conversely, the intervention based on awareness (Scenario A) significantly affected meaning (b = .56, p < .01; 95% CI = .17 to .96) but not pleasure (b = −.07, p = .74). In turn, pleasure (b = .51, p < .001; 95% CI = .42 to .61) and meaning (b = .50, p < .001; 95% CI = .40 to .60) both affected life satisfaction. Finally, life satisfaction affected the intention to engage in the food upcycling activity (b = .13, p < .05; 95% CI = .00 to .26).

The direct effects of the interventions on intention to engage in the food upcycling activity were not significant (X_{recipe} effect: .01, p = .95; $X_{awareness}$ effect: .03, p = .85). The indirect effect of the recipe intervention (Scenario B) on the dependent variable was significant through pleasure (X_{recipe} effect: .04, Boot S.E. = .03; 95% CI = .00 to .11), but not through meaning (X_{recipe} effect: −.01, Boot S.E. = .02; 95% CI = −.04 to .03). Conversely, the indirect effect of the awareness intervention (Scenario A) on the dependent variable was significant through meaning ($X_{awareness}$ effect: .04, Boot S.E. = .02; 95% CI = .00 to .09), but not through pleasure ($X_{awareness}$ effect: −.01, Boot S.E. = .02; 95% CI = −.05 to .02).

The results indicate that there are two pathways to improving consumer life satisfaction and the corresponding response (intention to upcycle food). The intervention designed to increase consumer food upcycling skills through a recipe increased life satisfaction via the mediation of pleasure, while the intervention focused on increasing awareness about food waste (Scenario A) improved life satisfaction via the mediation of meaning. Consequently, heightened life satisfaction led

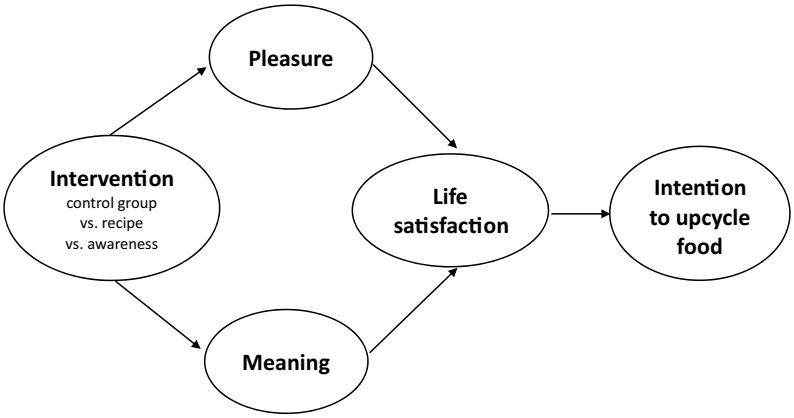

Fig. 1. The proposed model.

Table 4
Results of the mediation model (Study 3).

	Pleasure			
	B	t	*LLCI*	*ULCI*
X1 – intervention recipe	**.64**	**3.06****	**.23**	**1.05**
X2 – intervention awareness	-.07	-.34	-.48	.34
Control – environmental concern	.24	2.99**	.08	.39
Control – involvement in cooking activities	.23	3.66***	.11	.36
Control – frugality	.23	2.32*	.03	.42
Control – moral attitude	-.11	-1.56	-.26	.03
Control – gender	-.00	-.67	-.02	.01
Control – age	.33	1.88	-.01	.68
Control – household members	.14	1.90	-.01	.28
	Meaning			
	B	t	*LLCI*	*ULCI*
X1 – intervention recipe	-.19	-.93	-.59	.21
X2 – intervention awareness	**.56**	**2.80****	**.17**	**.96**
Control – environmental concern	.61	7.89***	.46	.76
Control – involvement in cooking activities	.11	1.76	-.01	.23
Control – frugality	.12	1.23	-.07	.31
Control – moral attitude	-.04	-.49	-.18	.11
Control – gender	-.01	-1.17	-.02	.01
Control – age	.42	2.45*	.08	.76
Control – household members	.15	2.14*	.01	.29
	Life Satisfaction (R^2 = .67)			
	B	t	*LLCI*	*ULCI*
X1 – intervention recipe	.03	.20	-.27	.33
X2 – intervention awareness	.02	.14	-.27	.32
Pleasure	**.51**	**10.52*****	**.42**	**.61**
Meaning	**.50**	**10.00*****	**.40**	**.60**
Control – environmental concern	-.05	-.79	-.17	.07
Control – involvement in cooking activities	-.00	-.10	-.10	.09
Control – frugality	-.04	-.50	-.17	.10
Control – moral attitude	.09	1.66	-.02	.19
Control – gender	-.01	-1.68	-.02	.00
Control – age	.01	.07	-.24	.26
Control – household members	.06	1.21	-.04	.17
	Intention to upcycle food (R^2 = .38)			
	B	t	*LLCI*	*ULCI*
X1 – intervention recipe	-.01	-.06	-.32	.31
X2 – intervention awareness	.03	.19	-.28	.34
Pleasure	-.00	-.00	-.12	.12
Meaning	-.05	-.89	-.18	.07
Life Satisfaction	**.13**	**1.98***	**.00**	**.26**
Control – environmental concern	.04	.54	-.09	.16
Control – involvement in cooking activities	-.00*	-.01	-.10	.09
Control – frugality	.51	6.88***	.36	.65
Control – moral attitude	-.23	-4.25***	-.34	-.13
Control – gender	.00	.53	-.01	.01
Control – age	-.07	-.53	-.33	.19
Control – household members	-.11	-2.03	-.22	-.00

N= 272. *, **, and *** indicate *p*-values of $< .05$, $< .01$, and $< .001$, respectively. LLCI = lower limit confidence interval; ULCI = upper limit confidence interval. Bold text indicates the hypothesized path is statistically significant. The paths connecting the dimensions with negative signs are all non-significant. This evidence further supports the hypothesized model illustrated in Fig. 1, in which the direct paths are absorbed by the indirect effects (e.g., the direct effects of pleasure and meaning on the intention to upcycle food are fully mediated by life satisfaction).

to increased consumer intentions to upcycle food.

4. Discussion

This research has demonstrated that engaging in sustainable activities to reduce household food waste, namely domestic food upcycling, can increase consumers' psychological well-being through two distinct pathways (Study 1). The first is the hedonic pathway, in which domestic food upcycling generates life satisfaction through emotional elements, such as the challenge of creating a tasty meal using leftovers. The second is a rational pathway, in which life satisfaction is increased due to the inherent practical characteristics associated with engaging in domestic food upcycling, such as reducing domestic food waste. These two pathways align with the research by Zarantonello et al. (2021; 2023) on the operationalization of well-being.

A subsequent survey study (Study 2) identified the most prominent barriers to the adoption of domestic food upcycling behaviors, informing the selection of educational interventions tested in Study 3. We found that an intervention aimed at informing consumers about household food waste (the awareness intervention) increased the intention to engage in domestic food upcycling via the rational path of perceived well-being (i.e., meaning). The recipe intervention, designed to educate consumers on creative ways to use leftovers, resulted in increased psychological well-being and a greater intention to engage in domestic food upcycling through the hedonic dimension of well-being (i.e., pleasure). Of these two interventions, the recipe intervention demonstrated a greater impact on perceived well-being and, in turn, the intention to engage in domestic food upcycling.

This research makes several important theoretical contributions. First, our results add to the food consumption literature, specifically the food waste literature (e.g., Aschemann-Witzel et al., 2018; Bhattacharya et al., 2021; Graham-Rowe et al., 2014; Reynolds et al., 2019; Romani et al., 2018; Zhang et al., 2021), by identifying domestic food upcycling as an alternative method for tackling household food waste that can be leveraged through increased psychological well-being. Second, our results contribute to the stream of literature connecting food consumption and psychological well-being (e.g., Batat et al., 2019; Donato and Monsurrò, 2024; Mugel et al., 2019; Zarantonello et al., 2021) by demonstrating that sustainable activities connected to food consumption (e.g., food waste reduction) can significantly contribute to consumers' psychological well-being. Third, our research adds to the growing body of literature on food upcycling (e.g., Bhatt et al., 2020; Spratt et al., 2021; Ye, et al., 2022; Zhang et al., 2021), suggesting that engaging in this activity within the domestic environment does not result in the stigmatization observed in previous studies (e.g., Edwards, 2021), but rather generates positive feelings (i.e., life satisfaction). Finally, our research contributes to the broader sustainability literature (e.g., Luchs et al., 2021; Pizzetti et al., 2023) by highlighting the link between caring (and sustainable) actions and psychological well-being, demonstrating how pursuing positive well-being can promote sustainable activities, such as reducing food waste.

Our results also provide important insights for managers and policymakers interested in designing initiatives to reduce food waste at the household level. While various efforts have been made to reduce domestic food waste (e.g., Aschemann-Witzel et al., 2015; Hebrok and Boks, 2017; Romani et al., 2018), there is limited research on domestic food upcycling. To the best of our knowledge, no prior work has explored the role of psychological well-being in explaining individuals' willingness to participate in activities aimed at reducing food waste. Based on our findings, we suggest two potential interventions to promote domestic food upcycling. The first focuses on enhancing the rational dimension of psychological well-being by providing information about the consequences of food waste and providing possible solutions, such as upcycling leftovers avoiding wasting them. For example, this information could be disseminated by institutional websites to raise awareness and directly support intentions to upcycle food.

The second intervention targets the hedonic dimension of psychological well-being, which was found to be more effective than the rational approach. This intervention involves leveraging the creative aspect of domestic food upcycling by providing individuals with specific recipes designed to creatively repurpose leftovers. Food managers can promote this same intervention by providing simple instructions or guidelines on their food packages, detailing how to combine new ingredients with leftovers to create new dishes. These recipes could also be featured in a dedicated section on a food brand's website or shared on its social media pages. Food retailers could also include food upcycling recipes in their promotional flyers, on their websites, and on their social media pages. By targeting the pleasure pathway of psychological well-being, this intervention will likely also increase consumers' positive

feelings toward the food brands or retailers proposing such interventions. Technology may provide additional opportunities to promote domestic food upcycling recipes, thereby reducing waste. Menu planning and shopping apps that provide upcycling recipes along with information about food waste, could represent an important self-regulatory resource.

The findings of our study offer valuable insights for various stakeholders; however, the following limitations should be considered while interpreting the results. First, our studies relied on self-reported data. Future research should focus on monitoring actual waste behaviors to acquire the most accurate data possible about domestic food upcycling.

Second, although we intentionally asked participants in Study 1 to write about their pleasant experiences connected with domestic food upcycling to align with the positive approach to sustainable consumption (Peter and Honea, 2012; White et al., 2019; Winterich et al., 2019;), future research may also uncover potential negative experiences associated with the activity, thereby highlighting distinctive barriers to the creative use of leftovers that need to be addressed using alternative interventions.

Third, our intervention addressing limited cooking skills focused on a simple recipe (i.e., French toast made from stale bread). Although this choice was aimed to reach the widest possible audience (not only those with the prior knowledge needed to follow more complex recipes), future research could test interventions based on more complex recipes to explore whether perceived recipe difficulty affects consumers' intentions to engage in domestic food upcycling.

Fourth, our interventions were aimed at overcoming two prominent barriers to domestic food upcycling—limited cooking skills and limited awareness of food waste effects. The effectiveness of educational programs aimed at addressing other barriers found to be relevant in this research, such as those related to social norms or negative emotions connected to domestic food upcycling, should be investigated in future research. Finally, our studies used convenience samples of consumers from the U.K. To strengthen the results, future studies could collect data from samples representative of the general population as well as data from different countries and regions, such as those in Asia or Africa.

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Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The identity of respondents was completely anonymous. Informed consent was obtained from all individual participants included in the study.

CRediT authorship contribution statement

Carmela Donato: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Silvia Grappi:** Writing – review & editing, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Simona Romani:** Writing – review & editing, Visualization, Supervision, Resources, Conceptualization.

Declaration of competing interest

All authors declare that they have no conflicts of interest.

Data availability

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.resconrec.2024.107770.

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