

Neshum Sapkota

**FOOD WASTE ASSESSMENT IN UNIVERSIDADE DO ALGARVE'S
CANTEEN: STATUS QUO, USERS' BEHAVIOR AND POTENTIAL
VALORIZATION**



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VALORIZATION**

Mestrado em Tecnologia de Alimentos

Trabalho efetuado sob a orientação de:

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Resumo

A cada etapa da cadeia alimentar existem perdas de alimentos, sendo os consumidores responsáveis por cerca de 35% de todos os resíduos alimentares. Para consumidores, fornecedores de serviços de alimentação, governos e organizações e instituições internacionais, o desperdício alimentar está, cada vez mais, a tornar-se uma questão essencial. Nos últimos anos, apesar de terem sido realizados bastantes estudos sobre desperdício alimentar, poucos estudos sobre desperdício de alimentos em cantinas e no contexto do Ensino Superior foram publicados. Os objetivos gerais deste estudo foram estimar a quantidade de desperdício alimentar na Cantina da Penha da Universidade do Algarve (UAAlg), compreender as práticas atuais na universidade relacionadas com o desperdício alimentar e propor método(s) para reduzir o desperdício alimentar em refeitórios universitários, frequentados quer por estudantes, quer por pessoal administrativo e académico.

Esta pesquisa analisou o desperdício de alimentos no refeitório da UAAlg no Campus da Penha, Faro, Portugal. A parte prática e experimental do trabalho foi realizada na cantina do Campus da Penha, Universidade do Algarve, durante o período de abril a junho de 2021. Este período resultou da necessidade de cumprimento de períodos de confinamento a nível nacional e condicionantes institucionais impostos devido à pandemia COVID-19. Resumidamente, durante um período inicial de aproximadamente 2 semanas, foram observadas e examinadas as práticas realizadas pelos funcionários da cantina para a preparação das refeições e os hábitos e comportamentos dos utentes durante a hora do almoço. Isso permitiu o planeamento dos tempos de amostragem e procedimentos de amostragem de dados qualitativos e quantitativos, mantendo as medidas de higiene e segurança sanitária estabelecidas e sem perturbar a preparação das refeições e do serviço. Assim, a avaliação do desperdício alimentar nas cantinas, apoiada e coordenada com os Serviços de Ação Social (SAS) da UAAlg, incluiu as fases de preparação (2 semanas em abril) e pós-consumo (durante 3 semanas entre final de abril e final de maio). Em cada fase, determinou-se a quantidade (relativa) por categoria de produto alimentar e tipo de desperdício alimentar. Complementarmente, um inquérito online, com versões em português e inglês e elaborado recorrendo aos Formulários Google, sobre as perceções sobre o desperdício alimentar aos funcionários e alunos utentes da cantina foi aplicado entre maio e junho.

Na fase de preparação, o desperdício alimentar, por item, durante variou entre 1% (peixe/pescado) e 78% (couve), com uma taxa média de desperdício de 9%. No que toca ao desperdício na fase de

pós-consumo, um número bastante relevante de refeições foi amostrado (n=483) considerando o número de refeições servidas durante o período de amostragem (n=751), ou seja, 64,3%. Das refeições amostradas, a maioria dos utilizadores optou pela refeição económica (n=252 vs. n=231 para a refeição completa) e pelo prato principal de carne (n=206 vs. n=173 para pescado e n=104 para o prato vegetariano). Os utilizadores que preferiram a refeição económica, de baixo custo, escolheram, por ordem decrescente, carne, pescado e opções vegetarianas como prato principal. Por outro lado, o prato de pescado foi o mais procurado pelos utilizadores que optaram por uma refeição completa, seguido de perto pelos pratos de carne e depois pelos vegetarianos.

Com base em pesagens, a percentagem global de desperdício alimentar foi de 22 %; sendo que, por item da refeição, as percentagens foram 11% (sopa), 21% (prato principal), 24% (salada) e 13% (sobremesa). Foram observadas diferenças de desperdício alimentar nas diversas tipologias de refeição. Quando se consideraram as frações edível e não-edível do desperdício, as percentagens de desperdício alimentar edível para os vários tipos e variedades de refeições variou entre 57% e 91%.

Analisando os resultados do inquérito, mais de 90% dos inquiridos fazem 1 a 3 ou 4 a 6 das suas refeições semanais na cantina. Quando questionados sobre a importância das questões ambientais, tais como aquelas delineadas nos objetivos de desenvolvimento sustentável (ODS) da ONU, maioria dos respondentes (88%) deu notas de 4 e 5 (ou seja, considerou "importante" e "muito importante"). No entanto, apenas 25%-32% dos respondentes procuraram informações recentemente sobre o desperdício de alimentos.

Para os respondentes, a importância relativa das fontes (potenciais) de desperdício de alimentos foram variou bastante. Os produtores foram maioritariamente vistos como “menos importantes” (1); assim como as indústrias agroalimentares (“pouco importantes”). Da mesma forma, distribuidores e supermercados também foram classificados como “menos importantes”. Curiosamente, restaurantes/café/refeitórios foram considerados tanto “menos importantes” como “mais importantes”, enquanto os consumidores foram classificados como “menos importantes” e “mais importantes”. Quando questionados sobre a quantidade de alimentos servidos na cantina do Campus da Penha, a maioria dos respondentes (cerca de 89%) considera que é “adequado” ou “muito adequado”. Não obstante, estimam que a percentagem de comida desperdiçada por refeição na cantina se situa entre 11 e 30%. Curiosamente, esta estimativa está em linha com as

percentagens obtidas através de amostragem (ver acima todos os valores do desperdício geral de alimentos na cantina).

Os dados obtidos neste estudo quantificam, pela primeira vez, o desperdício alimentar nas fases de preparação e de pós-consumo na cantina do Campus da Penha e são, por isso, auxiliares essenciais à gestão do serviço de cantina. Carecem de confirmação, atendendo às condições *sui generis* em que foram obtidos devido à crise pandémica da COVID-19 que vimos vivendo há quase 2 anos, e justificam a aplicação da metodologia noutros serviços de refeições, viz. cantinas, restaurantes e bares dos SAS UAlg. Por outro lado, propõe-se a conceção de uma campanha de “educação”, por exemplo divulgando os resultados obtidos neste estudo, para exortar os utilizadores (alunos e funcionários da UAlg) a mudarem os seus hábitos alimentares de forma a diminuir o desperdício alimentar.

Abstract

Food is discarded at every step of the food chain. Consumers are responsible for around 35% of all food waste. For consumers, food service providers, governments, and international organizations and institutions, it is becoming increasingly essential to tackle this issue. In recent years, just a few studies on food waste have been published. The overall goals of this study were to estimate the amount of food waste in one of the canteens of the Universidade do Algarve (UAlg), understand the current practices at the university relating the food waste and come up with a method to reduce food waste in university dining halls, which are frequented by both students and administrative and academic personnel.

This research looked at the food waste at the UAlg's dining hall in Campus da Penha, Faro, Portugal, which comprised 483 meals from the university's well-known dining hall. Food waste per item during the preparation stage varied from 1% (fish) to 78 % (collard), with a total wastage rate of 9%, according to the statistics. Based on weighing, 11 %, 21 %, 24 %, and 13% of the given food will be wasted for soup, meals, salad, and dessert, respectively. With additional classification, there were differences in meal kinds and variation among various meal variants. Because the amount of edible food waste for various types and variety meals ranges from 57 % to 91 %, SAS and the canteen management team should apply any strategy to reduce food waste as soon as feasible. Different strategies to decrease food waste should be examined, as well as the potential of developing a food sharing platform.

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List of Abbreviations

DECO: Portuguese Consumer Defense Association

EC: European Commission

EU: European Union

FAO: Food and Agriculture Organization

FSCM: Food Supply Chain Management

MSc: Master of Science

PhD: Doctor of Philosophy

SAS: Social Action Services (Serviços de Ação Social)

UAlg: University of Algarve (Universidade do Algarve)

Introduction

Food waste as World problem

Food waste is a critical issue for global food security and good environmental governance, as it is directly linked to environmental (e.g., energy, climate change, resource availability), economic (e.g., resource efficiency, price volatility, rising costs, consumption, waste management, commodity markets), and social (e.g., health, equality) consequences. Food waste's influence on the environment and food security has become a worldwide issue. According to earlier estimates, one-third to one-half of the world's food, or around 1.3 billion tons, is wasted (Gustavsson et al., 2011). This is linked to overconsumption of natural resources: food waste accounts for 10% of greenhouse gas emissions in developed nations and consumes 550 billion cubic meters of water globally (Stuart, 2009). Despite these figures, the world produces twice as much food as is necessary by nutritional demands per live person. In fact, by wasting less than a fifth of the food we squander, we could feed the world's roughly one billion hungry people. To feed all 9 billion people in 2050, food output will have to rise by 70% if present consumption trends are maintained. These worldwide statistics demonstrate that food waste need immediate action (Fox & Fimeche, 2013).

The environmental and food security effects of food waste have become a global concern. Previous figures suggest that one-third to one-half of the world's food, around 1.3 billion tons, is turned into waste (Gustavsson *et al.*, 2011). Despite these figures, per living human, twice as much food is produced globally than the nutritional requirements. With less than a quarter of the food we waste, nearly a billion people in the world who are hungry could be raised out of undernourishment (Fox & Fimeche, 2013).

Food waste is defined as food that is of good quality and fit for human use but is not consumed because it is discarded before or after it spoils. Food waste that occurred in the consumption was studied where 35 percent of all food waste in the last phase of the food supply chain (Lipinski *et al.*, 2013).

Food waste occurring in consumption can be generally divided into three types of food waste (Quested & Parry, 2011):

- Avoidable food waste: food that was still edible at some stage and was lost for many reasons (leftovers, out of date products);
- Food that some people consume, and others do not eat (e.g., bread crusts) or that can be consumed when a food is cooked in one way, but not in another, can be avoidable (e.g., potato skins);
- Inevitable food waste is a waste that is not edible in normal circumstances (e.g., meat and fish remain (bones), eggshells, tea bags, coffee grounds, hulks, peels) resulting from food or drink preparation. Inevitable food could be reprocessed but cannot be consumed.

Research by eu-fusions.org reported an estimate of 88 million tons of food waste in the EU-28 region, this prediction is for 2012 and contains both edible food and food-related inedible fraction. Households (47 ± 4 million tons) and processing (17 ± 13 million tons) are the sectors which contribute the most to food waste. In 2006, according to Eurostat, Portugal wasted approximately 635 and 385 tons of food from the stages of production and consumption, respectively.

Food waste from the food services industry, however, is considerable, accounting for around 14% of all food waste in the EU (Beretta *et al.*, 2013), ca. 12 million tons. Most of the food services study focuses on plate waste in school canteens to see if students are getting enough nutrition in school lunches. Despite their potentially considerable food waste production, a more comprehensive examination of overall food service losses, particularly in university and corporate cafeterias, has gotten little attention (Gallardo *et al.*, 2016). Focusing university research efforts on food waste creation might offer several benefits. To begin with, colleges house people with knowledge and expertise who can readily effect change in their surroundings. Second, food waste is generally a significant, if not the most significant, waste percentage created on college campuses (Gallardo *et al.*, 2016).

This issue is transversal in society and occurs in Academia. For example, in the dining halls of Çukurova University in Adana, Turkey, some 10.7% of the food consumed was lost. The students generated the most plate waste out of the three classes studied. It has also been shown that this

category also has the lowest exposure to food waste. Thus, the approaches for the reduction of food waste of the separate groups must be diverse (Ozcicek-Dolekoglu & Var, 2019).

The canteen of the School of Agriculture, one of the schools of the University of Lisbon (ISA-UL), promoted a reduction in plate waste and increased the recycling attitude of the users (mostly students) by displaying simple posters with educational messages and conducting guerrilla actions during the busy lunch hour. Total plate waste was decreased by 15%, resulting in a daily reduction of 17 percent in meal waste, a 55 percent reduction in bread waste, and a 42 percent reduction in meat waste. This demonstrated the need to raise staff knowledge of the problem of food waste. It also said that staff training on plating techniques, utilizing different sizes of utensils, and enabling customers to choose their own meal quantities will lead to a reduction in food waste (Pinto et al., 2018).

The Social Action Services of UAlg

The Universidade do Algarve (UAlg), founded in 1979, is a Portuguese public higher education institution located in the Algarve, mainland Portugal's southernmost region. Its headquarters and two of its three campuses are in Faro (the Gambelas and Penha campuses, respectively), with a third campus in Portimão. The institution has a student body of over 9,000 students and offers 40 graduate and 68 postgraduate programs (52 MSc and 16 PhD), as well as employs 700 permanent teaching and research personnel.

The Universidade do Algarve's Social Action Services (SAS) manages 9 University Residences with 558 beds for students pursuing bachelor's and master's degrees. The Food Sector of SAS includes many food units spread over the Universidade do Algarve's several campuses: three canteens, two grill restaurants, seven bars, and one restaurant. The academic population receives discounts on all units.

Thousands of meals are served every day in the SAS canteens and restaurants, with quality and diversity guaranteed. On the menus, you may choose between a meat or fish meal and a vegetarian dish, all of which are planned and prepared under the supervision of a nutritionist. Soup, main course, bread, dessert (sweet or fruit), and drink (water or machine juice) are all included in the

whole meal. The Campus da Penha, with 402 seats, and the Campus of Gambelas, with 594 seats, are the two largest canteens. The academic community can eat small meals or just a coffee in the SAS bars/ cafeterias during their breaks between classes.

The following are the operating hours:

Canteens: 11:45 a.m. to 2:30 p.m. (lunches) and 6:15 p.m. to 8:15 p.m. (dinners) Monday through Friday. *On Saturdays, only Cantina da Penha serves lunch.

Bars are open from 8:30 a.m. to 5:30 p.m., Monday through Friday, and some are open till 10:00 p.m. to serve staff and students studying in post-working hours degrees

Food waste related initiatives in Universidade do Algarve

At the time of writing, several initiatives were in place in the Universidade do Algarve that, from different angles, addressed the issue of food waste. Possibly the most visible is the collaboration with Re-food.

The non-profit organization Re-food 4 Good – Association was formed on July 18, 2011, to support the REFOOD MOVEMENT in Portugal. The Portuguese Government, through the Ministry of Employment, Solidarity and Social Security (Ministério do Trabalho, Solidariedade e Segurança Social), bestowed the status of IPSS – Instituição Particular de Solidariedade Social), which bestows both additional responsibility and tax advantages for donors, on 15th of April 2013.

The community's good will drives the Re-food Movement, which involves activity from institutions, merchants, companies, and notably local volunteers who distribute food, and is supported by continuing resource activation. The objective of Re-food is to give food from food establishments (stores, restaurants) that will not be consumed to people in need. Built-in procedures ensure that the Re-food Movement's actions are sustainable in three important areas: financial, environmental, and social.

The collaboration between Re-food and Universidade do Algarve has subsequently utilized foods that would have been waste by distributing the food to people who are in desperate need.

There are other collaborations with other local vendors. Waste derived from the preparation of meals wastes are given to other local vendors, one of the local vendors has a pedagogical farm located nearby Faro, they generally feed these preparation meal waste to the domestic animals that need feed. This specific farm operated and feed animals during the covid pandemic lockdown.

Objectives

The specific objectives were:

- Determine consumers' food waste in canteens of UAlg.
- Set-up an information campaign to increase consumers' (UAlg students and staff) perceptions on their food waste pattern and evaluate the impact of the campaign on the consumers' behavior.
- Propose some measures to decrease food waste.
- Discuss the possibility to establish a food sharing platform within UAlg premises as an impending initiative.

Literature Review

Definitions of food waste

There is currently no consensus on what constitutes "food loss", "food wastage" or "food waste". In its recent "Report on how to minimize food waste: Strategies for a more efficient food chain in the EU", the European Parliament provided a definition of "food waste" (European Parliament 2011). On January 19, 2012, the European Parliament passed this as a resolution. There, the term "food waste" is defined as "all foodstuffs discarded from the food supply chain for economic or aesthetic reasons, or due to the proximity of the "use-by date", but which are still perfectly edible and fit for human consumption and, in the absence of any other use, are eventually eliminated and disposed of, generating negative externalities from an environmental standpoint". Even this definition, however, is not legally obligatory nor uniform. "Food losses might be qualitative, such as decreased nutritional value and unfavorable changes in taste, texture, or color, or quantitative, such as weight or volume loss" (Buzby & Hyman, 2012). Food waste is sometimes considered a subcategory of "food loss", and vice versa.

Few decades ago, the FAO (1981) attempted to create a "reference" definition for food waste and food loss as part of the Save Food program (see below). The following definitions have been passed about as suitable starting points:

Food loss and waste refers to the loss of bulk (quantitative) or nutritional value (qualitative) of food - edible portions - in the supply chain intended for human consumption. Even if it is directed to a non-food use, food that was originally intended for human consumption but escapes the human food chain is termed food loss or waste (feed, bioenergy).

Food loss refers to food that is spilt, spoiled, or otherwise lost throughout its journey through the food supply chain, or suffers a quality or value drop before reaching the end-product stage. Food loss is common in the food supply chain during the production, postharvest, processing, and distribution phases.

Food waste refers to food that has gone through the whole food supply chain and is of excellent quality and fit for consumption, but is not consumed because it is thrown, whether before or after it has spoiled.”

The studies that are accessible usually follow their own definitions that are limited down to their field of study. The FAO offered a first definition of “food loss”, which included “wholesome edible material meant for human consumption that is instead rejected, lost, degraded, or eaten by pests” at any stage in the food supply chain (FAO 1981). “Food losses refer to the decrease of edible food mass for human consumption along the supply chain,” according to Gustavsson et al. (2011).

Garrone et al. (2012) of the Politecnico di Milano distinguishes between "surplus food" and "food waste". Surplus food is defined as edible food items that are not consumed by the consumers or persons for whom they are produced, processed, distributed, purchased, or provided for different reasons. Food waste, on the other hand, refers to the portion of surplus food that is not recovered for human consumption, animal feeding, or the production of commodities or energy.

Møller *et al.* (2012), for example, reject the phrase "food waste" because of the negative connotations of the word "waste" in connection to food. They prefer to use the phrase "food loss," which is defined as "food that is not appropriate for full price sale and must therefore be delivered to various forms of waste management". Food waste can be handled in a variety of ways, including sale at a discounted price, donation to social organizations, use as an ingredient or co-product, as animal feed or a component of animal feed, production of biogas, incineration (including energy usage), or composting.

Herein, the definitions below (from Priefer *et al.*, 2013) will be followed:

- Food loss is defined as the amount of food produced for human consumption but lost in the supply chain due to a variety of factors.
- Food waste is a subset of food loss, and it refers to the quantity of edible food that is lost because of human activity or inaction.

This distinction is created because residues and sorted out goods can be reused in the manufacturing process, especially at the beginning of the food chain. As a result, not all food losses

go to waste. When it is difficult to determine whether residues are discarded or processed and directed to human nutrition, the phrase "food loss" is used, which is a more neutral word. Food waste, on the other hand, is defined as food that was intended for human consumption but was removed from the supply chain, even if it was put to a non-food purpose. Food loss and waste are not synonymous. Products that can no longer be sold but are recovered for human use and so stay in the food supply chain are not considered food loss or waste (Priefer *et al.*, 2013).

Food losses and waste were also differentiated by Teitscheid & Ritter (2011), Waarts *et al.* (2011), and Parfitt *et al.* (2010) in a different perspective. According to this distinction, "food losses" occur at the beginning of the food supply chain, during cultivation, harvesting, post-harvest treatment, and processing, whereas "food waste" occurs at the conclusion of the food supply chain, during retail and ultimate consumption. As a result, "food waste" is linked to human behavior and is visible because of company, government, and individual consumer actions (Bloom 2010). Other researchers distinguish between "avoidable", "possibly/partially avoidable", and "unavoidable" food waste (Priefer *et al.*, 2013):

Food waste that might have been avoided are goods that are still fit for human consumption at the time of disposal or items that would have been edible if consumed sooner.

Food waste that is possibly/partially avoidable refers to goods or components that are not consumed owing to customer preferences (e.g., bread crusts, apple skins), or that can be eaten when food is cooked one way but not another (e.g., bread crusts, apple skins) (the skin of fried poultry is usually eaten, the skin of boiled poultry normally not). As a blend of preventable and unavoidable waste, this category also includes leftovers in canteens or restaurants.

Food waste that cannot be avoided includes goods or substances that are not fit for human consumption according to current food standards. This includes non-edible parts (such as banana peels, bones, and eggshells) as well as goods that have been damaged by weather, illnesses, or pests and are no longer edible.

Origin and reasons for food loss and waste

Supply chains are complicated structures made up of many different businesses and economic agents all working together to provide the final product to the consumer. Since the contributions of Davis & Goldberg (1958) and Malassis (1969), it has been widely recognized that food production in industrial economies is organized in complex systems in which diverse specialized firms interact intensively and progressively modify raw materials, adding intermediate input-ingredient services, and anything else that adds value (Priefer *et al.*, 2013).

The term Food Supply Chain Management (FSCM) was developed to describe the actions or operations that occur during the manufacturing, distribution, and consumption of various foods to maintain their safety and quality in efficient and effective ways (Blandon *et al.*, 2009). The significance of elements like food quality, safety, and freshness within a restricted time frame distinguishes FSCM from other supply chains such as furniture logistics and supply chain management, making the underlying supply chain more complicated and harder to manage (La Scalia *et al.*, 2016).

The food business plays a critical role in providing the essentials for a variety of human activities and behaviors (Cooper and Ellram, 1993). Food should be kept, transported, and retailed as soon as it is harvested or produced so that it may reach its end buyers on time. Two-thirds of all food waste (about 1 billion tons) occurs in the supply chain, which includes harvesting, transportation, and storage (Fritz and Schiefer, 2008). Take fruit and vegetables, for example: in 2011, 492 million tons of perishable food were lost worldwide owing to inefficient and inadequate food supply chain management (Gustavsson *et al.*, 2011).

Food losses can be caused by a variety of factors (Göbel *et al.*, 2012), including (1) the definition of process- and market-based standards and quality requirements, (2) the legal framework for ensuring food safety, (3) common market practice, (4) human errors, (5) technical faults, or (6) logistic errors, as well as (7) cultural influences. Food losses can occur anywhere throughout the food supply chain, from farm to table. Production of vegetable and animal-derived goods, food business (including processing), distribution, wholesale, retail, and consumption are all part of this chain.

Losses in Primary Production

In developing nations, output losses are much higher than in developed countries, and are mostly caused by insufficient harvesting technology, inappropriate crop processing, insufficient transportation, inaccurate storage, and insufficient infrastructure (Priefer *et al.*, 2013). According to Grethe *et al.* (2011), the causes of these losses must be viewed primarily in the context of developing and emerging countries' socioeconomic and technological development, with the following factors contributing to food losses in those countries: a lack of knowledge, a lack of management skills (especially in the trading sector), insufficient governmental regulation, and a lack of political will.

Only a few studies have been conducted on food losses in the marine environment. Most of the marine animals are dead, dying, or seriously damaged when they are discarded as bycatch. It is projected that 8% of the world's population would be affected by this attitude (Kelleher 2005). European and Japanese seas have the greatest discard rates; 40 to 50% of the fish taken in Europe is bycatch (Priefer *et al.*, 2013). Global losses appear to have decreased significantly between 1994 and 2005, according to surveys: in 1994, losses totaled 27 million tons, whereas losses in 2004 totaled 7.3 million tons (Gustavsson *et al.* 2011). Given the vast variations in fishing tactics used throughout the world, as well as the ongoing use of practices that result in huge losses for some nations, there is a lot of room for improvement in this area.

Losses in Processing and Packaging

Overproduction is an issue that arises in the processing sector as well. Even though many manufacturers strive to prevent large inventory levels by providing 'just in time' (Göbel *et al.* 2012), surplus production cannot be avoided. Extrapolations based on data from a Vienna bakery business imply that each of its 32 locations returns a daily surplus of 38 kg to the headquarters (Schneider & Wassermann 2004). The returns total over 12 tons each branch per year, equating to a 17% surplus in baking items for the whole bakery network.

Food preparation produces residues that might still be consumed by humans. This comprises leftovers from cutting items to a certain size and form, as well as rejected goods that depart from the norm owing to manufacturing flaws or broken packing. These goods are occasionally used in

other sectors, but they are typically discarded since it saves time and money (Gustavsson et al. 2011). Losses occur in the industrial processing of bread and bakery goods owing to the employment of punch technology (for example, for bread rolls), which are not reworked but discarded (Göbel *et al.* 2012). By structuring the bread items, the punch scrap may be prevented. According to Lee & Willis (2010), in the United Kingdom, 16 percent of the raw ingredients used in food and beverage manufacturing are wasted during processing. Side-products such as buttermilk, skimmed milk, and whey are generated in the manufacture of milk and dairy products, one of Germany's major food businesses, and are sold on the market or reintroduced into the production process. Approximately 5% of processed milk in Austria escapes the production process and is either discarded or repurposed (for example, as pig feed) (Priefer *et al.*, 2013).

According to interviews with frozen food companies, commodities are left over due to insufficient storage and warehousing, seasonality (Easter, Christmas, barbeque season), or changes in the product range. Furthermore, the minimal durability of seasonal items is typically insufficient to justify offering them again the next season. Limited storage capacity and high storage costs are other factors against longer storage durations from the manufacturers' standpoint (Schneider & Wassermann 2004).

In Germany, losses during animal transit are less than 2% (Göbel *et al.* 2012). In the case of cattle, the loss in 2011 amounted to 74,000 animals (VDF, 2012). In terms of repurposing, the meat business is quite competent. Parts of the leftovers, including as fat, skin, joints, and tendons, are used to melt fat and make gelatin. Other applications include animal feed and meat-and-bone meal (fertilizer or fuel), as well as the pharmaceutical sector. Tails, paws, and some offal, which are not widely recognized as food in Western society, are exported in part (Göbel *et al.* 2012).

Several EU laws like Regulation (EC) No. 852/2004 (hygiene of food stuff general), Regulation (EC) No. 853/2004 (hygiene of food of animal origin), and Regulation (EC) No 854/2004 (official controls on products of animal origin intended for human consumption), along with Regulation (EC) No. 882/2004 (official controls performed to ensure the verification of compliance with feed and food law)” control the processing of animal-derived goods such as milk, dairy products, meat, and sausages, enforcing a stringent hygiene regime. The EU laws also require detailed documentation of the food chain, which must be traceable via a package identifying mark. Because

of their microbial sensitivity, a substantial portion of meat and sausage products are very perishable. The handling of raw materials necessitates rigorous adherence to the cold chain. Due to short turnaround periods, the danger of disposal is particularly significant in supermarkets and discounters, which usually provide big quantities and a wide variety of raw meat products. Breaks in the cold chain, temperature extremes, and microbiological contaminations all lead to items being discarded (Göbel *et al.* 2012; Waarts *et al.* 2011).

Losses in Distribution, Wholesale and Retail

Food must first be carried and distributed before it can be sold. Furthermore, poor transportation may result in losses or damages to items or packaging during shipment. Damage can also occur when products are loaded or unloaded, or when they are stacked. Another issue in logistics is warehousing, where excessive storage of products can result in the minimum durability date no longer meeting the standards of sale or even spoilage (Göbel *et al.* 2012). While merchants believe that consumers are the primary source of food waste, there are some voices that stress the trade sector's role, citing the fight for profit in the face of fierce competition as the primary reason of food waste (Kreutzberger & Thurn 2011;). The shops only show the amount of trash they generate on site, while transferring their potential losses to the regions of manufacturing and consumption, according to critics (Monier *et al.* 2010).

According to Gustavsson *et al.* (2011), fruit and vegetable production losses in Europe, North America, Oceania, and the industrialized portion of Asia are quite significant, at over 20%. Roots and tubers, such as potatoes, are particularly vulnerable to losses because of the high-quality requirements expected by retailers. According to Jones (2005), growers in Florida do not bring in 15% of their orange production because market prices are not profitable. Parts of the discarded goods are reused, for example, in animal feed and compost manufacturing, or are utilized in fermentation facilities to generate energy (Schneider 2008). According to Stenmarck *et al.* (2011), who questioned several retail and wholesale operators in Scandinavian nations, there is a 7% surplus of bread items to satisfy customer expectations.

Customers avoid purchasing food that is nearing its expiration date and actively seek for the freshest items since there is no financial incentive to do so. Schneider & Wassermann (2004),

among others, investigated the quantity of food waste in the retail sector and found that owing to the complicated logistic networks, even items with a remaining minimum durability of up to half a year are removed from the typical sales channel. Even though there are numerous reasons for the emergence of food losses in distribution, wholesale, and retail, the amounts appear to be quite modest. According to estimates (Monier *et al.* 2010), the trade sector accounts for just 5% of the overall quantity of food waste in the EU.

Losses in the Hospitality Sector

The "hospitality sector" refers to all operations involving food preparation and service outside of the home. Commercial businesses such as hotels, restaurants, cafeterias, pubs, and catering services, as well as municipal businesses such as workplace canteens, hospitals, retirement homes, schools, and prisons, fall under this category. A considerable quantity of food is consumed in restaurants, cafeterias, canteens, and catering services rather than at home. This percentage is expected to rise in the future, since the younger generation is more accustomed to this type of food supply (for example, in schools) and eats out more frequently than their parents (Engström & Carlson-Kanyama 2004).

The portion size is one issue that contributes to food waste in the gastronomy industry. Individual requirements are not met by standardized sizes. While pre-filled plates usually result in food leftovers, customers eat 92% of the food they place on their own plates (Wansink & Cheney 2005). Apart from meal quantity, there are other significant aspects to consider in school and hospital catering. In schools, limited finances, and caterers' lack of enthusiasm to make high-quality cuisine resulted in the children not enjoying their lunch (Monier *et al.* 2010). The hour you choose for lunch is also significant. The time you choose for lunch is also significant. Engström & Carlson-Kanyama (2004) conducted questionnaires with students and discovered that many of them do not complete their meals due to a lack of time. Because there is no distinct break time for playing, students eat quickly to make the most of the rest of their lunch hour. Patients in hospitals have no say over mealtimes or portion amounts. Patients have a loss of autonomy, which, combined with indigestion and poor food quality, causes them to consume less than they would under normal conditions (Monier *et al.* 2010).

In the hotel industry, legal considerations are also crucial. The EU food hygiene package's two-hour guarantee on unrefrigerated items results in waste since caterers must meet a two-hour food safety guarantee after delivery. Furthermore, Waarts *et al.* (2011) discovered that chain parties such as caterers, retailers, and residual flow processors create stricter norms (e.g., relating to hygiene rules) for themselves based on EU legislation to avoid reputational damage, and that food is frequently wasted due to product liability concerns.

Engström & Carlson-Kanyama (2004) spent several days observing primary school cafeterias and two eateries in Stockholm's central business district, weighing trash and interviewing staff. Food was lost at a rate of 20% on average, with the majority (50%) owing to leftovers on the plates. Food losses were minimal because of storage and preparation.

Losses in Private Households

Many studies have shown that private consumption accounts for most of the food waste in industrialized countries (Grethe *et al.* 2011). According to a Forsa poll commissioned by the BMELV, 58 percent of respondents threw food waste on a regular basis (LZ 2011). Leftovers (on plates) opened food products (half full, sliced open), and packaged goods are all examples of waste that may be avoided. There are a variety of reasons why people throw away edible meals, all of which will be discussed in further detail below:

- Food procurement and storage are not planned for or known about.
- Purchases made on impulse (buying items that are not currently needed)
- Purchase of new items that the customer later "dislikes"
- Insufficient packaging sizes (e.g., oversized ready to eat meals)
- Ineffective storage management (e.g., inadequate wrapping)
- Date labels ('best before', 'use by') might be confusing.
- Food preparation procedures and abilities are lacking.
- Meal planning skills are lacking.
- preparing many meals
- Inability to recombine leftovers into new meals due to a lack of abilities.

Private households' losses in Portugal

Between September and November 2015, DECO (Portuguese Consumer Defense Association) conducted a study in which 1 725 Portuguese customers aged 25 to 74 years old were asked about food waste concerns. According to the study, more than half of customers acknowledged to tossing away food that had beyond its expiration date, and two-thirds of those polled had no idea what the terms "use by" and "best by" meant. In terms of waste, the research found that 14% of those polled threw food away because they prepared too much. Seven out of ten people said they go to the supermarket to shop. The most important element that led to this assertion (80%) was price, followed by proximity, product diversity, and supply of low-cost items. The study uncovered a lot regarding food waste, particularly the fact that more than half of the respondents said they threw away out-of-date food. In the case of perishable items (the phrase refers to "use by") such as meat or fresh fish, eggs, milk cakes with cream or fresh cheese, this approach is appropriate (DECO, 2015).

Table 1: A summary of the major contributing variables that contribute to food waste at various levels of the food chain in industrialized countries.

Stages	Contributory Factors
Agricultural Production	<p>Sorting of items at the farm gate owing to strict quality requirements established by large-scale distributors on weight, size, form, and appearance.</p> <p>Market prices that are insufficient to cover the cost of harvesting</p> <p>Due to supply agreements with retail chains, there is an overabundance of merchandise.</p> <p>During harvesting, the crop was ruined.</p>
Manufacturing	<p>Products that aren't the right size are reduced to fit or discarded completely.</p> <p>Manufacturing process inconsistency, resulting in deformed or damaged goods</p> <p>Quality loss due to contamination in the manufacturing process</p> <p>Food deterioration because of packaging issues</p> <p>Supermarket own-brand excess output that can't be sold elsewhere</p> <p>Excess stock because of "take-back" mechanisms and order cancellations</p>

Distribution and Wholesale/Retail	<p>Inadequate cold storage/cold chain disruption</p> <p>Packaging flaws that cause product harm</p> <p>Overstocking because of erroneous ordering and demand forecasts</p> <p>Retailers are required to purchase a diverse variety of items and brands from the same manufacturer to benefit from lower pricing.</p> <p>Failure to meet basic food safety requirements (e.g., microbial contamination, pesticide residues)</p> <p>'Buy one, get one free' marketing tactics</p>
Hospitality Industry (Restaurants and canteens)	<p>Dishes that are too big</p> <p>Buffets with set prices encourage individuals to take more food than they can consume.</p> <p>Separation of catering-sized packages in hotels and catering (for example, jams, cereals, juice, and milk) or the usage of individual piece packets that do not fulfill the customer's demands</p> <p>Difficulties determining demand (number of customers)</p> <p>EU sanitary regulations, such as the two-hour guarantee on non-refrigerated food, are in place.</p>
Households	<p>Food procurement and storage are not planned for or known about.</p> <p>Purchases made on impulse (buying items that are not currently needed)</p> <p>Purchase of new items that the customer later "dislikes"</p> <p>Insufficient packaging sizes (e.g., oversized ready to eat meals)</p> <p>Ineffective storage management (e.g., inadequate wrapping)</p> <p>Date labels ('best before', 'use by') might be confusing.</p> <p>Food preparation procedures and abilities are lacking.</p> <p>Meal planning skills are lacking.</p> <p>Preparing many meals</p> <p>Inability to recombine leftovers into new meals due to a lack of abilities</p>

Sources: Parfitt et al. (2010); Monier *et al.* (2010); Gustavsson *et al.* (2011); IMECHE (2013)

Issues and amounts of food loss and waste

Data on global food waste is currently few and measuring methods have proven inconsistent. Australia, Austria, Canada, China, Denmark, Estonia, Germany, Ghana, Italy, Malta, the

Netherlands, New Zealand, Norway, the Kingdom of Saudi Arabia, Sweden, the United Kingdom, and the United States are among the 17 countries identified as having high-quality data and compatible reporting.

The scarcity of data and its variability make it difficult to obtain a worldwide estimate of total food losses and waste. The information provided comes from studies and research conducted by institutions and international organizations, most of which are on a national level. There are few and insufficient assessments of losses that occur at the beginning of the food supply chain. However, more thorough information on the ultimate consumption analysis of food waste is available. Researchers can collect accurate data on the composition of household trash using certain monitoring approaches, such as waste sorting analysis. One of the few worldwide assessments accessible is FAO research from 2011, which puts yearly global waste at around 1.3 billion tons, or around one-third of total food output. Furthermore, study gives a worldwide picture of losses and waste that occur across the whole food chain, or "from the field to the fork": on average, only 43% of goods grown for food are consumed (Barilla Center for Food & Nutrition, 2015).

In addition to the 600-kcal reduction caused by inefficiencies in the harvesting, transportation, storage, and processing stages, the conversion of food production (primarily grains) into livestock feed has the greatest impact on the number of daily kilocalories available for human consumption. This conversion results in a net loss of 1,200 kcal/person. While providing food to animals isn't really food waste, it does raise a lot of issues among those researching food security. Finally, food retail distribution generates extra waste (equivalent to 800 kcal), resulting in a caloric content of just 2,000 kcal that may be used (Barilla Center for Food & Nutrition, 2015).

World regions are examined in greater depth to provide insight into the sorts of data and research used to create estimations. These are grouped according to UNEP's regional categorization, which will serve as the foundation for UNEP's Regional Food Waste Working Groups, which will be launched in four areas in 2021 (United Nations Environment Program, 2021).

Region Specific Data

It is claimed by Xue *et al.* (2017) that in low-income nations, most of the food loss occurs upstream in the food chain, particularly in agriculture, with just a small amount of food waste occurring downstream at the consumer level. In high-income nations, the situation is reversed: most of the food is lost at the consumer level. Meanwhile, in low-income nations, inefficient agricultural and logistical methods are the leading causes of food waste. The most profitable aspect of reducing food loss in low-income nations is finding solutions for inadequate storage and delivery infrastructure. Furthermore, consumer-related food waste is uncommon in low-income nations, and food waste is rarely a voluntary act (Xue *et al.*, 2017).

In Africa, research assessing food waste in eight nations were included (Table 2). All these studies focused on the home sector, with one research also including waste estimates from food service and retail. The Ghanaian research by Miezah *et al.* (2015) is remarkable for being the only African household estimate with a high level of confidence for the Food Waste Index. This comprehensive study provides Ghana with a solid evidence foundation for acting on food waste and other types of household waste. One interesting finding was that food waste creation was similar across all income groups: the average daily food waste generation for low-, medium-, and high-income households was 80, 86, and 86 kg/capita/year, respectively (United Nations Environment Program, 2021).

There are seven estimates for four countries in Latin America and the Caribbean (in Belize, there are multiple estimates) (Table 2). There were no estimates from Caribbean islands, and all these nations were in mainland Latin America (South and Central America). Because all the useable estimates are for the residential sector, there is still a significant data gap for food service and retail waste in Latin America and the Caribbean (United Nations Environment Program, 2021).

The Asia and Pacific area have a significant amount of data due to its many sub-regions (Australasia, Southern Asia, Southeast Asia, Eastern Asia, and Central Asia). In 11 nations, 45 data points were found across all industries. Most of these data points (32) came from the household sector, with nine from the food service industry and four from retail (Table 2) (United Nations Environment Program, 2021).

There were 14 estimates for food waste in West Asia, spreading among 11 research papers in six countries (Table 2). Household estimates made up eleven of the data points, with two retail and one food service estimate each. Except for the Saudi Arabian household estimate, all data items are of medium confidence. There is more information available in the household sector than previously thought: national surveys have been conducted in Israel, Saudi Arabia, and Bahrain (United Nations Environment Program, 2021).

Table 2: Data points relating to households' food waste estimate (kg/capita) from studies for different countries.

Region	Country	Reference	Food waste estimate (kg/capita)
Africa	<i>Ethiopia</i>	Assefa,2017	92
	<i>Ghana</i>	Miezah et al., 2015	84
	<i>Kenya</i>	Takeuchi, 2019	99
	<i>Nigeria</i>	Orhorhoro et al., 2017	189
	<i>Ruwanda</i>	Mucyo, 2013	164
	<i>South Africa</i>	Ramukhwatho, 2016	134
	<i>United Republic of Tanzania</i>	Oberlin, 2013	119
	<i>Zambia</i>	Edema et al, 2012	78
Latin America and the Caribbean	<i>Belize (Belize City)</i>	Inter-American Development Bank, 2011	34
	<i>Brazil</i>	Arujo et al., 2018	60
	<i>Colombia</i>	JICA, 2013	70
	<i>Mexico</i>	Kemper et al., 2019	94
Asia and the Pacific	<i>Australia</i>	Arcadis, 2019	102
	<i>Bangladesh</i>	Salam et al., 2012	74
	<i>China</i>	Zhang et al., 2020	150
	<i>India</i>	Ramkrishna, 2016	58
	<i>Indonesia</i>	Dhokhikah et al., 2015	77
	<i>Japan</i>	Food Industry Policy Office, 2017	64
	<i>Malaysia</i>	Jereme et al., 2013	112
	<i>New Zealand</i>	Sunshine Yates Consulting, 2018	61
	<i>Pakistan</i>	JICA, 2015	88
	<i>Sri Lanka (Katunayake)</i>	JICA, 2016	78
<i>Viet Nam</i>	Thanh et al., 2010	85	
West Asia	<i>Bahrain</i>	Alayam, 2018	132
	<i>Georgia</i>	Denafas et al., 2014	101

	<i>Iraq (Karbala)</i>	Al-Mas'udi & Al-Haydari, 2015	142
	<i>Israel</i>	Leket Israel, 2019	105
	<i>Lebanon</i>	Chalak et al., 2019	105
	<i>Saudi Arabia</i>	SAGO, 2019	105
North America	<i>Canada</i>	Environment and Climate Change Canada, 2019	79
	<i>U.S. A</i>	US Environmental Protection Agency, 2020a	59
Europe	<i>Austria</i>	Environment Agency Austria, 2017	39
	<i>Denmark</i>	Danish Environmental Protection Agency, 2018	79
	<i>France</i>	ADEME, 2016	85
	<i>Germany</i>	Schmidt et al., 2019	75
	<i>Ireland</i>	Stenmarck et al., 2016	55
	<i>Italy</i>	Giordano et al., 2019	67
	<i>Netherlands</i>	The Netherland Nutrition Centre Foundation, 2019	50
	<i>Norway</i>	Hanssen et al., 2016	79
	<i>Russian Federation</i>	Tiarcenter, 2019	33
	<i>Spain</i>	Caldeira et al., 2019	78
	<i>Sweden</i>	Swedish Environmental Protection Agency, 2014	81
	<i>U.K. of Great Britain and Northern Ireland</i>	WRAP, 2020b	77

Source: United Nation Environment Program, 2021

In North America, the Canadian household paper (Environment and Climate Change Canada, 2019) is a new study that combines 56 waste compositional assessments of home trash to create a national average. Some previous estimates, such as Buzby *et al.* (2014), and popular assumptions have suggested that U.S. home trash is quite high.

The methodology and breadth of previous US assessments have varied. For example, Buzby *et al.* (2014) calculated food waste (or, to use their terminology, food loss) in the consumption stages of the supply chain (which included both household and food service) by comparing the amount of food entering this stage (Loss-Adjusted Food Availability data) with the amount consumed. While this approach and others like it have numerous advantages, they are not designed to detect food

waste over time. As a result, they fail to fulfill the following criteria for inclusion in the current study:

- Food waste isn't measured directly; instead, it's estimated using a mass balance method.
- The food service and home industries are successfully integrated.
- Parts of food waste that aren't edible aren't counted.

With a huge amount of data points across all industries, Europe is the most well-documented region. BIO Intelligence Service (2010), Stenmarck *et al.* (2016), and, more recently, Caldeira *et al.* (2017) have all produced meta-analyses using European data (2019). The European data search was built on these foundations. As a result, a significant portion of Europe's data came from secondary literature that sufficiently documented the methods of the research to ensure that the methodological requirements were satisfied.

According to estimates, Europe throws out 89 million tons of food per year, or 180 kg per person. Home waste accounts for the largest proportion of food waste, accounting for 42 percent of the total (25 percent of the food expenditure per pound) and 76 kg per person per year (60 percent of which could be avoided). The percentages ascribed to food processing (39%) and catering and restaurant services (14%) are also significant (United Nations Environment Program, 2021).

Impacts of Food Waste

Ordinary customers/ consumers are most likely to observe the amount of money he spent for the goods in the shop. Few consider the background, such as how many stages and nations a food product must pass through before a buyer can purchase it in a shop, and how all these actions are eventually repaid (Seberini, 2020). Food production is one of the most resource-intensive sectors, with significant levels of hazardous gas emissions. Food waste degrades all resources utilized in the production, transportation, and distribution of food because it wastes water, energy, soil, and money, all of which have an environmental impact. The FAO's Food wastage footprint: Impacts on Natural Resources describes the precise implications of food waste (FAO, 2019). We usually classify them according to their environmental, economic, and societal consequences.

Environmental Impact

Food produced that is not consumed has a huge environmental impact. Food that goes uneaten and ends up in landfills contributes to global warming. When food waste decomposes, it releases dangerous methane into the atmosphere. Methane is a very toxic greenhouse gas that is 21 times more powerful than carbon dioxide. Food waste gas accounts for 7% of total greenhouse gas emissions worldwide. Instead of methane, less damaging carbon dioxide might be emitted into the air if these foods were composted correctly. Aside from food dumps, another aspect that has an impact on the ecosystem is the delivery of food over large distances or its subsequent disposal. These operations need a considerable amount of fuel, which is adversely affected in the long run by exhaust gas emissions (Seberini *et al.*, 2020).

Food waste has piqued the interest of environmental organizations, policymakers, analysts, and scholars in recent decades (Mirabella *et al.*, 2014). Food Wastage Footprint (FWF) is an FAO initiative that illustrates that decreasing food waste is a reasonable goal for creating more sustainable ways of producing and consuming food, as well as giving a worldwide picture of the environmental footprint along the food chain. The project's initial step involved mapping the worldwide footprint of garbage to assess its effects on the atmosphere, water, soil, and biodiversity. Food security and availability on a global scale is a serious issue. Higher food production will result in increased GHG emissions due to deforestation when land is used for food production, as well as increased waste production if sustainable mitigating methods are not implemented (Hoornweg *et al.*, 2013). The overall cost of food waste was estimated to be at \$ 2.6 billion per year, comprising \$ 700 billion in environmental costs and \$ 900 billion in social costs (FAO, 2019).

Food waste has a social consequence

Even though adequate food is produced across the world, almost a billion people go hungry or are malnourished. Many countries waste massive amounts of food that might be consumed in underdeveloped nations. Even if the items are still edible and safe, they are discarded. Within individual developed countries, similar issues arise. A portion of the population has enough access to food, up to their excess, but there are socially vulnerable segments of the population that do not

have the means to purchase high-quality food, and in other cases do not have enough food at all. At European level, according to the European Parliament's Committee on Agriculture, up to 50% of edible and harmless food is unnecessarily depreciated and thrown away in European homes, supermarkets, restaurants and along the entire food chain every year. While 79 million citizens live below the poverty line and 16 million depend on food aid provided by charities (Seberini *et al.*, 2020).

Expectedly food waste impacts economy

Producers and consumers are both intertwined in the present economic structure. This indicates that customer preferences are one of the variables that influence food producers' behavior and waste creation. However, the economic system's operation is far too complicated and intertwined with numerous links and interactions. Food waste has an impact on pricing policies in industrialized countries. Increased waste is linked to influencing demand, resulting in an increase in the price of food stockpiles. As a result, individuals on low salaries who can't afford to spend extra money on food are the ones who are most vulnerable. Food prices are also heavily influenced by environmental factors. The worldwide economic worth of food waste is estimated to be over 1000 billion USD per year, but this amount climbs to 2600 billion USD when hidden environmental costs are factored in (FAO, 2019).

Methodology

Study Plan

Figure 1 (below) depicts the plan followed in this study. The practical, experimental part of the work was carried out in the canteen on the Campus da Penha, Universidade do Algarve, during April-June 2021. This period resulted from the need to comply with previous time(s) of national lockdown and institutional constraints imposed due to the COVID-19 pandemic. In fact, in-person classes were halted and almost all (expected) users, both students and staff, from using the canteen; as a result, we were unable to collect “relevant” data on food waste during the preparation of meals or post-consumer stages before the end early-April.

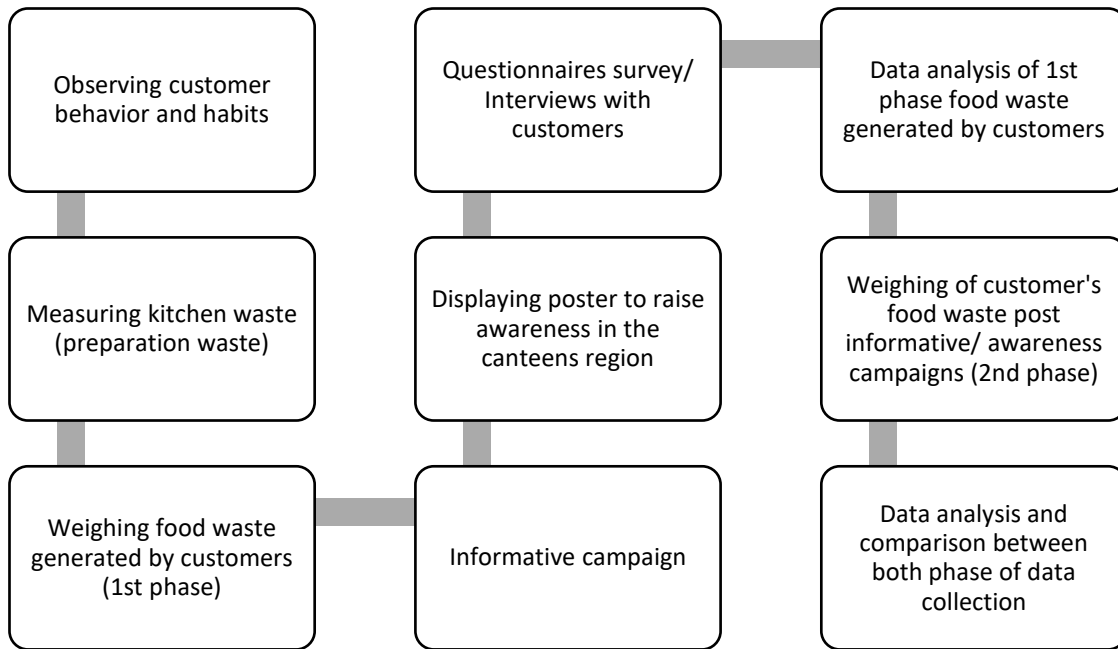


Figure 1: Flowchart for the Initial plan to conduct consumer survey

Briefly, during an initial period, spanning approximately 2 weeks, the practices carried out by the canteen staff for the preparation of the meals and the users’ habits and behaviors during lunch time were observed and examined. This allowed for the planning of the sampling times and procedures to collect qualitative and quantitative data, keeping established hygienic and health safety measures and without disturbing the preparation of meals and lunch service.

Thence, the assessment of food waste in the canteens, supported and coordinated with the SAS of UAlg, encompassed the pre-preparation, pre-cooking, serving and post-consumption stages (Figure 2). In each stage, we determine the (relative) amount per category of food product and type of food waste (see below).

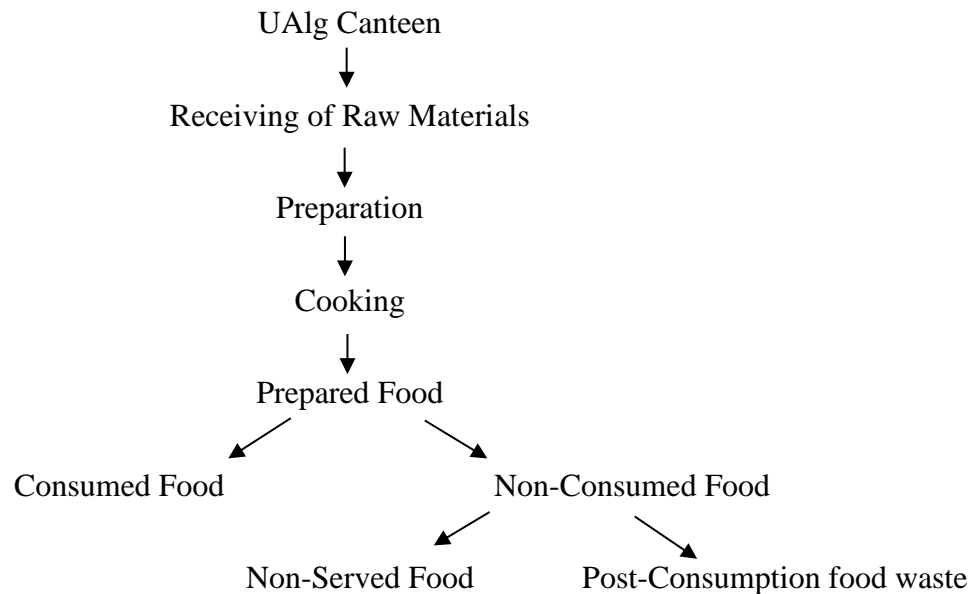


Figure 2: Simple flowchart of the stages mentioned above.

Complementarily, an online survey about the perceptions about food waste was applied to staff and students that are users of the canteen. The survey, in accordance with Política de Proteção de Dados e de Privacidade da Universidade do Algarve (that is compliant with the framework of the Regulamento Geral de Proteção de Dados; EU 2016), was approved by the Responsible Person at UAlg. With versions in Portuguese and English, the survey was prepared using Google Forms (Figure 3), available for respondents between May and June, and included the following questions:

- How often do you use the canteen during the week?
- How important are environmental issues to you, such as those outlined in the UN's sustainable development goals?
- Have you recently heard or sought information about food waste?
- Sort, from 1-less important to 6-most important, the following sources of food waste?

- In your opinion, the amount of food served in the canteen is:
- What percentage of food do you estimate that is wasted, on average, per meal in the canteen?

Food waste assessment in University of Algarve's canteens: status quo, users' behaviour, and potential valorization

This questionnaire is part of a final Master's degree in Food Technology (DEA, ISE UAlg) entitled "Food waste in UAlg canteens: current status, users' perspective and potential for recovery".

The main objectives of the study are: to determine food waste in UAlg canteens; develop an information/awareness campaign to increase users' perception of their food waste patterns, and propose measures to reduce food waste.

All information collected is confidential and the questionnaire is anonymous. The data are collected only for the purposes of the study "Food waste in UAlg canteens", the confidentiality of its analysis and exclusive use by the University of Algarve is guaranteed, with a data retention period being the minimum necessary to carry out the study. Data analysis will be carried out in accordance with the terms and conditions of the Data Protection Policy which is accessible at www.ualg.pt. The results will not be analyzed individually, but only in an aggregate, together with the response of all participants.

If you need any further clarification regarding the participation or filling in the questionnaire, please contact us, by phone 289 800 900 ext 6533 or via estevess@ualg.pt and janibal@ualg.pt.

Because your collaboration is very important, we ask that you respond with sincerity.

***Obrigatório**

1. I expressly authorize the processing of personal data by the University of Algarve, for the purposes of the study "Food waste in UAlg canteens", according to the terms of information on data processing and the Data Protection Policy which are available at www.ualg.pt. I am aware that I can withdraw consent or exercise data protection rights, namely the rights of complaint, access, rectification, opposition, limitation of processing or deletion, by contacting the person in charge of the Data Protection of the University of Algarve by email rgpd@ualg.pt, and if so deemed necessary, submit a complaint to the National Data Protection Commission, through the contacts available at www.cnpd.pt. *

Marcas apenas uma oval.

Yes
 No *Avançar para a secção 4 (Acknowledgment)*

2. In addition, I accept the general conditions and terms of the Google Forms Data Protection Policies *

Marcas apenas uma oval.

Yes
 No

Figure 3: Illustrative image of the initial page of the Google forms survey.

Food waste in the preparation and pre-cooking stages

To quantify the food waste during the pre-preparation and pre-cooking stages, the raw food products and ingredients were identified/classified and weighted (± 60 kg) before and after pre-preparation and pre-cooking procedures. The personnel kindly collaborated by keeping the different types of wastes apart so that it can be weighed (± 3.30 kg). The waste percentage (W, %) per type of raw food products was calculated as:

$$W = \frac{W_w}{W_0} \cdot 100\% \quad (\text{Eq. 1})$$

where W_w is waste weight (kg) and W_0 (kg) is the initial weight. For example, on 20th April the initial weight W_0 of the potatoes used was 60 kg and after the preparation of potatoes for the meal the weight of potato waste generated W_w was 3.30 kg.

Food waste generated by users of the canteen

To quantitatively examine the food waste generated by users in the post-consumption stage, a preliminary and then a two-step approach was followed.

Initially, starting on March 25, 2021, a random sample of $n=30$ items to get the reference values for desserts, bread, and fruits were weighted (± 0.1 g). Then, the food waste originated by users (post-consumption stage) in the canteen on Campus da Penha during lunchtime service was assessed for four weeks, from April 28 to May 21, 2021 ($n=16$ days). On these occasions, a two-step sampling scheme was implemented.

Because food is provided by the staff to users upon request, served meals, salads, and soup plates were weighted before being delivered to the user in a tray (on average, $n=30$ meals, salads and soups were sampled per day; in total, $n=524$ meals, salads, and soup plates). This allowed to estimate the (initial) mean weight of the distinct food items served per meal/tray. Since users can only return their trays to one place on the canteen (Figure 4), returned trays were randomly sampled from that place (on average $n=25$ trays were assessed per day; in total, $n=483$ trays were sampled). Canteen staff helped extensively in managing the trays yet to be sampled and evaluated.

Each tray was then taken to the weighing station (Figure 4), where the type of meal (Full or Economical) and type of main dish (meat, fish/seafood, or vegetarian) were identified, and the contents was separated and weighed (± 0.1 g).

The type of meals available were: Economical, which includes main dish and salad or dessert, and costs 2.35 €; Full, that includes soup, main dish, salad and dessert, and costs 2.85 €.



Figure 4. Pictures of the structure holding the trays and the weighing station.

In brief, after identifying the type of meal and main dish on the tray, isolated food supplements such as soup, salad, and dessert were measured one by one on their respective plates, while for the main course plate, we visually separated edible and non-edible portions of the meal and weighed it differently on different plates (provided measuring plates), leaving the meal plate completely empty.

Edible and Non-edible food waste were identified as: Edible food wastes were defined as any food that was intended to be consumed, including fat, whereas skin, bones, spines, and viscera were classified as non-edible food waste.

The leftovers on the trays were separated into following categories:

- Type of meal (Economic or Full)
- Variety of meal (Vegetarian, Meat, and Fish)
- Total weight of dish with leftover
- Total weight of remaining soup
- Total weight of remaining salad
- Total weight of dessert/fruits leftover
- Total weight of bread leftover
- Edible leftover
- Non-edible leftover

Weight data were annotated in sheets (Figure 5) at time of sampling.

FORM FOR WEIGHT OF POST-CONSUMPTION LEFT-OVERS
Tabela de registo de massas: pós-consumo

Data/Date: _____

TYPE OF SIDE DISH Tipo de acompanhamento	TYPE OF MEAL Tipo de refeição	VARIETY OF MEAL Variedade do prato (g)	TOTAL WEIGHT DISH* Massa total do prato* (g)	TOTAL WEIGHT SOUP Massa total da sopa	TOTAL WEIGHT FRUIT/DESSERT Massa total da fruta/sobremesa (g)	TOTAL WEIGHT OF SALAD Massa total da salada	TOTAL WEIGHT OF BREAD Massa total do pão	*DISH LEFTOVERS CATEGORIES *Categorias de desperdício por prato				OBS. Obs.
								*EDIBLE MUSCLE (INCL. FAT) Músculo edível (incl. gordura)	*NONEDIBLE SKIN/BONES/SPINES/VISCERA/ETC. Pele/Ossos/Espinhas/Visceras/etc.	*SIDE DISHES Acompanhamentos	*SALAD Salada	
	Economic or Fast	veg/Meat/Fish	Weight the dish/leftovers	Weight the soup/remaining soup	Weight the fruit or the dessert/remaining dessert	Weight the dish/remaining salad	Weight remaining bread	Weight the edible parts/muscle incl. fat, minus portion of the leftovers	Weight the inedible parts/muscle such as skin, bones, larger spines, viscera and the like	Weight the edible portion remaining via: potatoes/chips/rice/pasta/beans/etc.		Miscellaneous excretions

Figure 5. Illustrative image of the sampling sheet.

The number of meals served per day of sampling together with type of meal and class of user (student, teaching, other staff) were kindly provided by the SAS UA1g (Table 3). During March-June 2021, the average number of meals served increased from 34 meals/day in March (right after the end of lockdown) to 120 meals/day in April and 197 meals/day in May. The canteen is mostly used by students (registered >90% of the meals served).

Table 3: Number of meals served on Campus de Penha Canteen

Month (2021)	No. Meals	Avg. No. Meals/Day*	No. students	% Students
Mar.	750	34	505	67%
Apr.	2635	120	2406	91%
May	4340	197	4115	95%
Jun.	2102	96	1886	90%

*22 working days per month

Data Analysis

Initially, the “raw” weighted amounts of the different categories of food waste in the pre-preparation, pre-cooking and then in the post-consumer stages were compiled in Excel spreadsheets. Therein, the following weight percentage were determined:

- Pre-preparation/Pre-cooking wastes
 - Waste (%) for all raw food products were calculated through abovementioned Equation 1.
- Post-consumptions waste categories
 - Overall meal leftover
 - Soup
 - Salad
 - Dessert
 - Edible and Non-edible food waste per type of meal
 - Economical
 - Full
 - Edible and Non-edible waste per type of dish
 - Vegetarian
 - Meat
 - Seafood (Fish)

To calculate these values, relatively simple formulas were used; for example, for overall meal leftover W_M (%) we used:

$$W_M = \frac{W_{leftover}}{W_{total}} \cdot 100\% \quad (\text{Eq. 2})$$

where $W_{leftover}$ is the net weight of the leftovers (g) and W_{total} is the total weight of the dish/soup/salad/dessert. This general formula (Equation 2) was used to calculate soup, salad, and dessert leftover percentages. To calculate edible and non-edible food waste for type and variety of meal, Excel =IF() function was used on overall meal leftover to distinguish the abovementioned categories.

Some variables above were computed daily and may have varying averages to account for the fact that different types of meals might have been served on varied-sized plates, namely the weights of main course plate, meal served, soup plate, soup served, salad plate, salad served, dessert plate, and dessert served

Data is presented as % of total waste in the case of pre-preparation stage and as average values (\pm standard deviation) or as % (w/w) in the case of post-consumption stage. For the latter, the following summary values (%) were obtained:

- Overall food waste
- Edible and non-edible food waste per type of meal (economical and full)
- Edible and non-edible food waste per type of main dish (vegetarian, meat, and seafood/fish).

The results from the online survey were compiled in a Google Sheets spreadsheet. Frequency distributions (%) of answers were calculated for multiple choice questions and plotted. Open, textual question(s) were analyzed and abridged.

Results and Discussion.

Food Waste in the Pre-preparation and Pre-cooking stages

Table 4 summarizes the amount and percentage of waste per item type of raw food products and/or ingredients originated from the preparation of meals (pre-preparation and pre-cooking stages) in the Penha canteen.

The food waste per item type showed a wide range of estimates, ranging from 1% (fish) to 78 % (“collard”). Raw products such as turkey or pork were completely used and originated no waste.

Table 4. Waste amount and percentage of raw food products

Variety	Raw food products/Ingredients	Net weight (kg)	Waste (g)	% Waste
Sea Food	Fish	30400	270	1%
	Squids	12000	1300	11%
Meat	Chicken	16000	850	5%
	Turkey	2000	0	0%
	Pork	10300	0	0%
Vegetables	Potato	223000	18450	8%
	Carrot	22000	150	1%
	Spinach	4500	2750	61%
	Broccoli	2250	550	24%
	Pumpkin	80300	5000	6%
	Onion	15000	4500	30%
	Radish	3000	750	25%
	Collard	6000	4700	78%
	Average	426750	39270	9%

According to Rojas et al. (2021), food waste created during the preparation stage from 5 different educational institutions in great metropolitan area of Costa Rica is 26.10 %, which is greater than campus de Penha canteens average. Even though the waste percentage is lower, the canteen should focus its waste reduction plan with respect to the data obtained. The institution has restaurants and

cafes with several users and other factors that can act in a variety of ways. Identifying what behaviors or situations exist in canteen kitchens that result in a larger percentage of food waste in the preparation area. For example, the waste percentage for green leafy vegetables (collard and spinach) are much higher than expected.

Food waste generated by users of the canteen

Meals served and sampled

The number of meals served per type (economical and full) and per type of main dish (meat, seafood, and vegetarian) that were assessed during the period of sampling is shown in Figure 6. Overall, quite a relevant number of meals was sampled (n=483) considering the number of meals served during the period of sampling (n=751), i.e., 64.3%.

Of the meals sampled, most users opted for the economical meal (n=252 vs. n= 231 for the full meal) and for the main dish including meat (n=206 vs. n=173 for seafood and n=104 for the vegetarian dish) (Figure 6). Users preferred the lower-cost economical meal, sequentially choosing meat, seafood, and vegetarian options as their main dishes (Figure 7). On the other hand, the seafood dish was the most popular with the users that opted for eating a full meal, followed closely by the meat and then the vegetarian dishes (Figure 7).

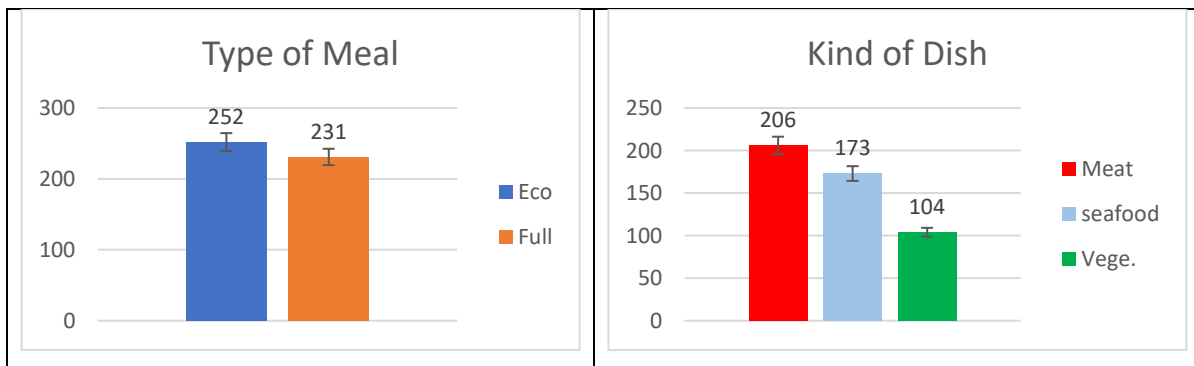


Figure 6. Chart for users' preference on type and variety of meal

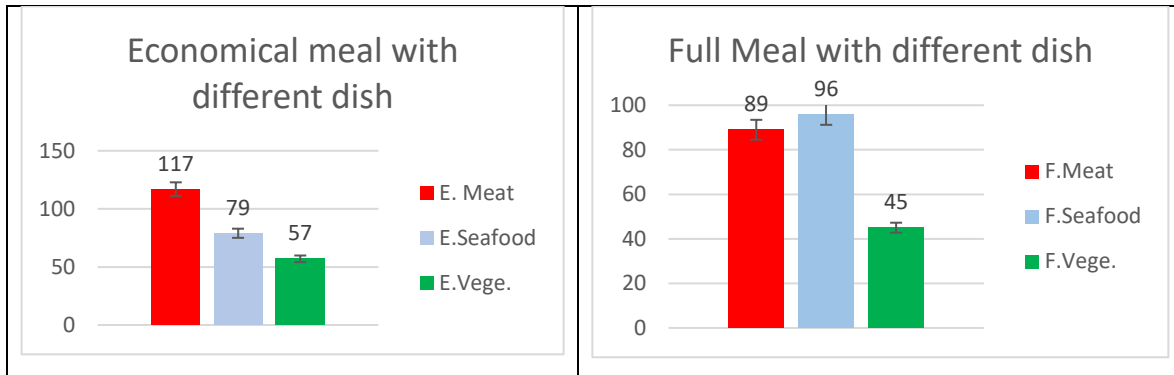


Figure 7. Users' preference on different variety of food within economical and full meal

According to Pinto et al., (2018) meat-based dishes were more popular among the users of University of Lisbon followed by fish (seafood) and vegetarian dishes, which is similar to our findings as well.

Food waste generated by users of the canteen

Figure 8 depicts the average % of waste per item of meal (soup, dish, salad, and dessert) that was originated by users of the canteen in Campus da Penha over the course of the sampling period (four and a half weeks). Estimates ranging from 11 % (soup) to 24 % (salad) were obtained. Thus, salad and the main dish (21%) were the items of the meal with the highest waste (%). Again vegetables (i.e., salad) showed a greater percentage of waste as was found during the pre-preparation and pre-cooking stages (see above).

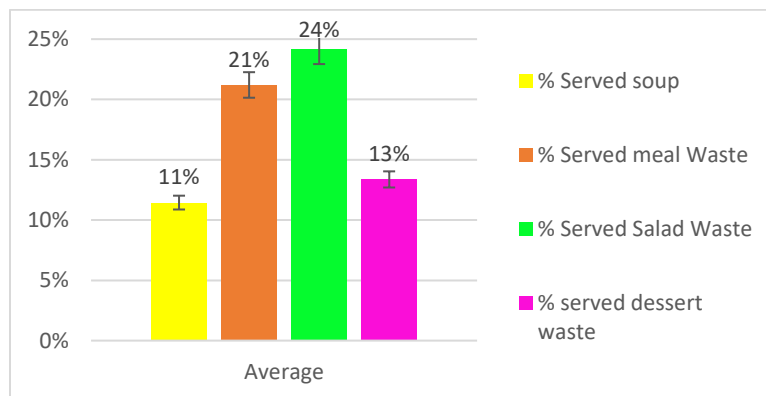


Figure 8. Served waste (%) per item of meals served in the UAlg Campus da Penha canteen.

Engström and Carlsson-Kanyama (2004), studied food loss in Swedish food service institutions, including two canteens, and reported food waste ranging from 46 g to 115 g per meal, like Pinto et al. (2018), who found 41–118 g/meal for the main course plate at the University of Lisbon. Meanwhile, the main course meal waste in our case varied from 8.2 g to 348.3 g, which is quite significant when compared to the research stated above. However, because all customers received the same standard meal composition, the fact that the staff consistently delivered the same amount of meal components may have contributed to the significant plate waste reported in the current study.

Our serving soup waste percentage was 11 %, which is like Pinto et al. (2018) finding of 8 to 10%. It was suggested that this was due to the soup being overly watery, or that the pupils just took the soup without inquiry, even though they did not want it. Whereas waste percentages for salad and dessert were not able to be compared because of unavailability of data.

Edible and nonedible food waste

To scrutinize the food waste originated by users of the canteen in Campus da Penha, the edible and nonedible fractions of the food waste were assessed and tentatively quantified. When looking at type of meal, economical vs. full, the waste was determined to be 20 % and 22 %, respectively (Figure 9). These waste figures demonstrate that the waste originated by users for both types of meals is similar, and they wisely pick the types of meals, demonstrating their understanding of the quantity to consume to avoid hunger and demonstrating great meal planning abilities.

Moreover, the percentage of edible food waste in the “total” food waste originated from the two types of meals was 62 % for economical meals and 63 % for full meals. The nonedible portion of the waste for the two types of meals was 15 % and 20 % of total waste for an economical lunch and a full dinner, respectively (Figure 9). Because vegetarian meals do not contain any nonedible parts, the nonedible percentage for vegetarian meals was usually 0 %.

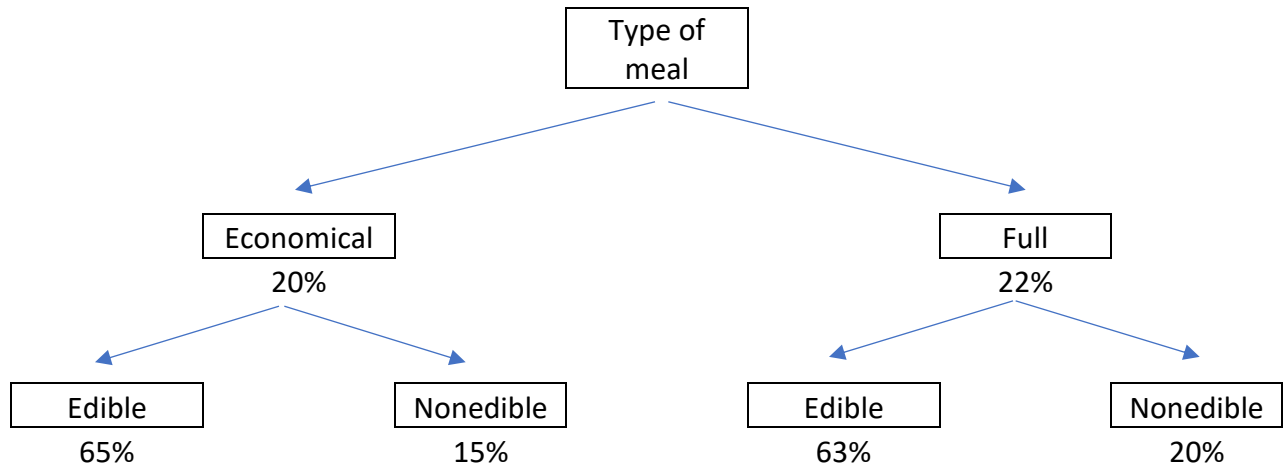


Figure 9. Meal waste (%), edible and nonedible, between the different types of meal.

As the way we categorised our food wastages as edible and non-edible, we could not find any other articles or literatures for the comparisons.

When considering the type of dish, food waste from dishes including meat, or including seafood or from vegetarian dishes was similar, 23 %, 20 %, and 20 %, respectively (Figure 10). Most of these wastes were classified as edible, 74 %, 62 %, and 69 %, respectively for meat, seafood, and vegetarian dishes. The nonedible waste for seafood dishes was greater than for meat dishes, 29% and 21% of total waste, respectively. Vegetarian dishes had no waste.

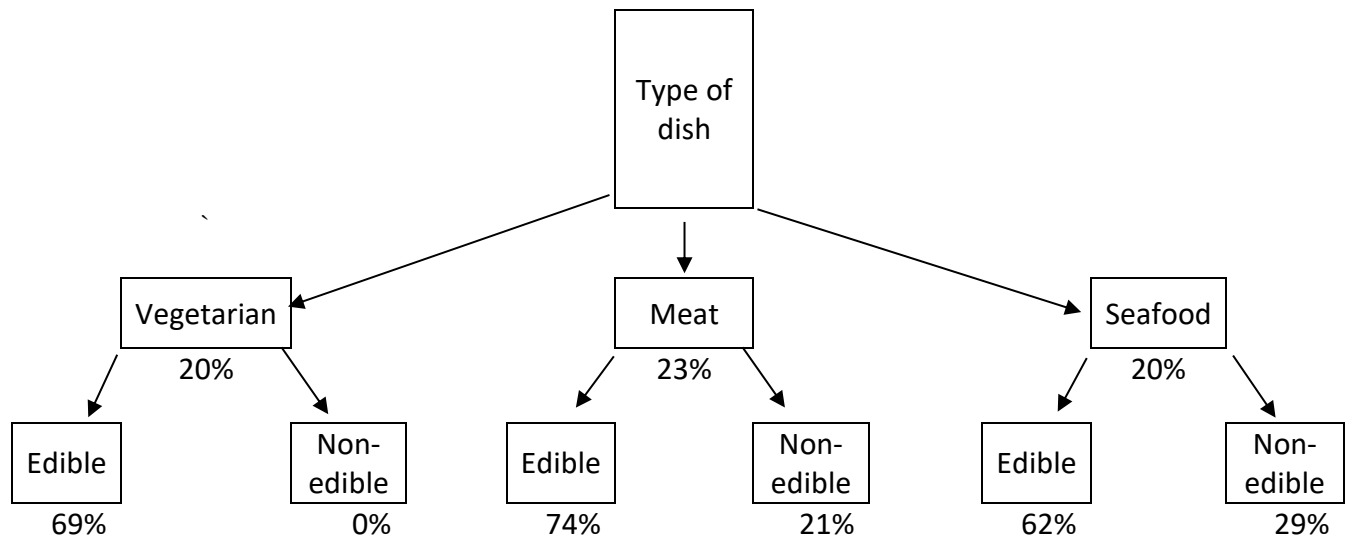
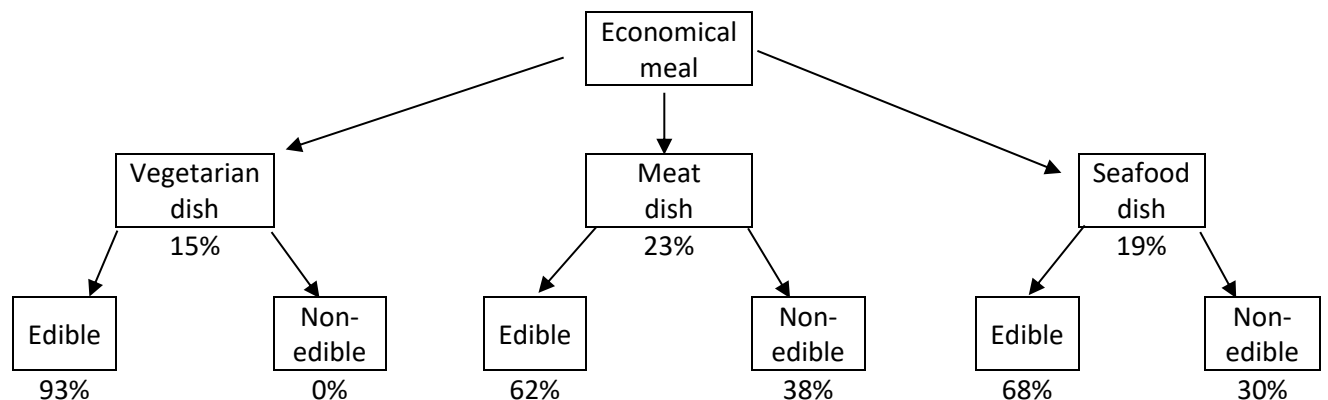


Figure 10. Meal waste (%), edible vs. nonedible, among the different types of dishes.

There were differences in the percentages of edible and nonedible waste originated from the distinct types of meals (economical and full) and per type of dish (meat, seafood, and vegetarian) (Figure 11). Generally, economical meals originated less waste (23 %, 19 %, and 15 % of the overall meal in when the main dishes were meat, seafood, and vegetarian, respectively) than full meals (24%, 20% and 24%, respectively). In terms of edible meal waste, vegetarian dish waste was found to be greater than seafood and meat dish waste, respectively 93 %, 68 %, and 62 % in economical meals and 91%, 57% and 76% in full meals. Nonedible meal waste for meat dishes is greater than for seafood dishes, 38 % vs. 30 % respectively. Nonedible meal waste for a full meal on a seafood dish is greater than for a full meal on a meat dish, at 42 percent and 24 percent, respectively. No waste (or negligible) waste was found in vegetarian dishes whatever the type of meal.



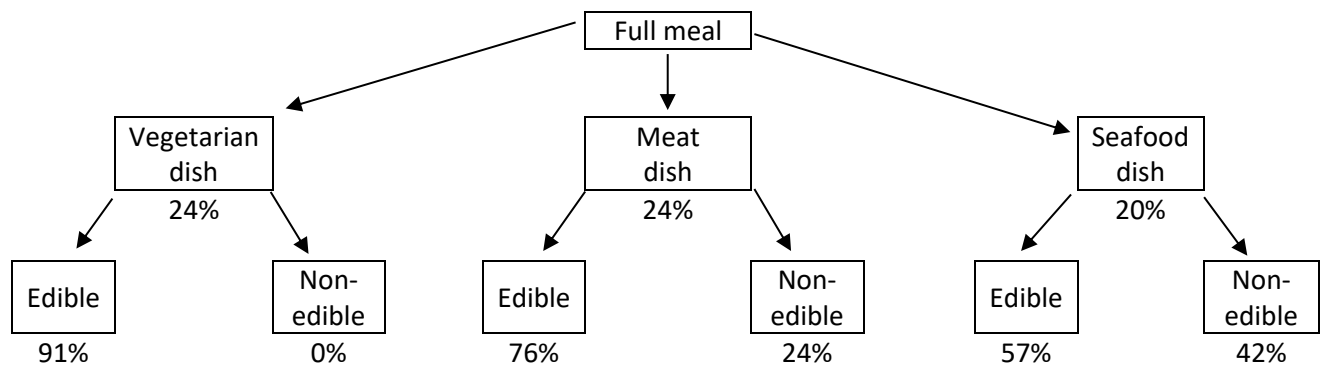


Figure 11. Waste (%), edible and nonedible, per type of meal and dish.

Online survey on the perceptions of canteen users about food waste

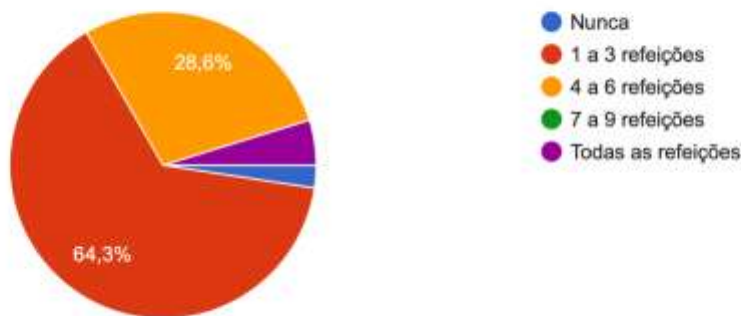
The results from the online survey about the perceptions about food waste applied to staff and students that are users of the canteen on Campus da Penha are summarized and plotted.

Forty-six (n=46) users of the canteen responded to the questionnaire during the period of application. The respondents were aged 18-52 years old (mean \pm std. dev. of 26.3 ± 8.8 years, median=23 years), 45% female/55% male, the majority coming from the Algarve (65%) and now living primarily in Faro (36%), Olhão (12%) and Albufeira (9%), and were mostly students (ca. 80%) pursuing degrees in Visual Arts, Engineering, Management, Marketing, and Tourism.

More than 90% of the respondents have 1 to 3 or 4 to 6 of their meals weekly in the canteen (Figure 12).

Com que frequência utiliza a cantina durante a semana?

42 respostas



How often do you use the canteen during the week?

4 respostas



Figure 12. Survey results showing users' no. of meals in the canteen.

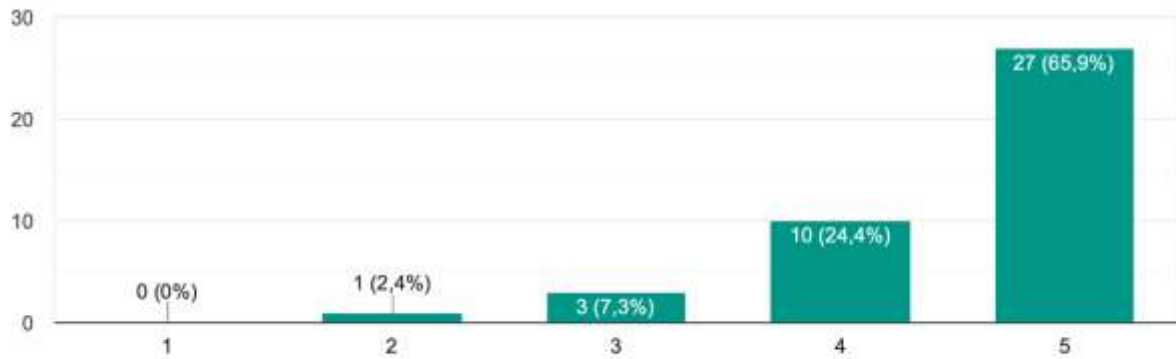
According to a survey performed by Abdelaal et al. (2019), over 40% of respondents cooked at home just once a week or less, relying on the housing cafeteria or ordering meals from neighboring eateries. Other students relied on the cafeteria in part, but also prepared their own meals and brought food from home.

When asked about their perceptions, namely the importance of the environmental issues such as those outlined in the UN's development goals (<https://sdgs.un.org/goals>), most respondents (88%) gave scores of 4 and 5 (i.e., "important" and "very important") (Figure 13). However, only 25%-

32% of the respondents have recently heard or sought information about food waste (Figure 13). The people that looked up information about food waste, did it on the Internet or via social media.

Que importância têm para si as questões ambientais, como por exemplo aquelas apontadas nos objetivos de desenvolvimentos sustentável da ONU?

41 respostas



How important are environmental issues to you, such as those outlined in the UN's sustainable development goals?

4 respostas

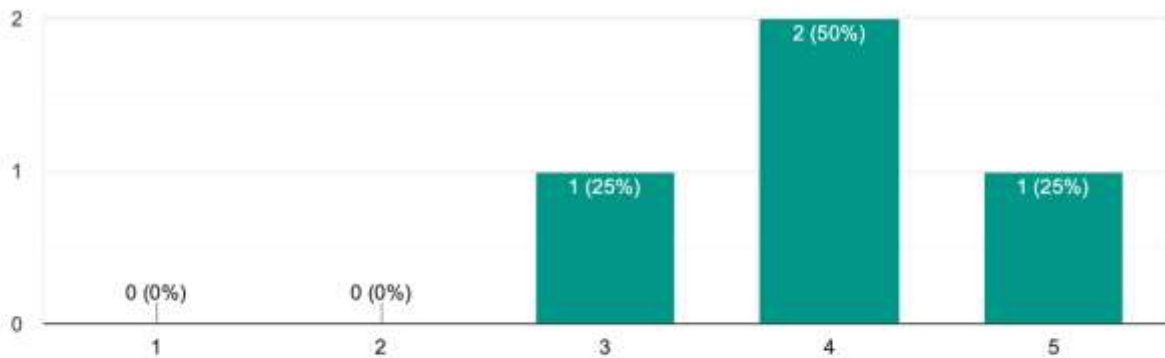
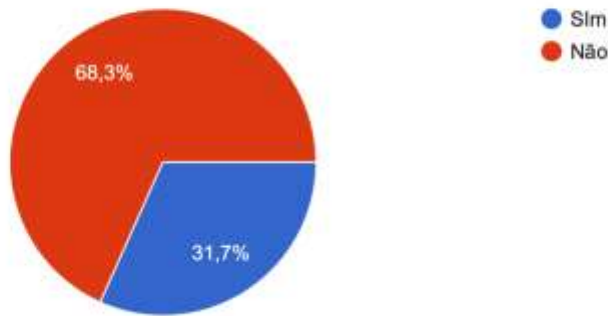


Figure 13. Survey results of users' importance given to environmental issues

According to Papaj (2016), 73.4 % of Portuguese interviewees did not locate or seek for information about food waste, 34.8% did not hear or read anything, and the remaining 56.6%

acquired information through the internet, television, work, or school, with a substantial portion forgetting.

Tem, recentemente, ouvido ou procurado informação acerca do desperdício alimentar?
41 respostas



Have you recently heard or sought information about food waste?
4 respostas

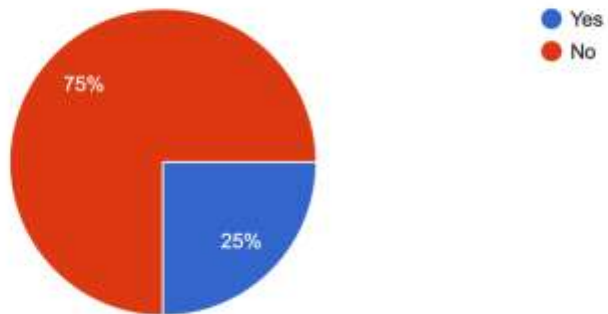
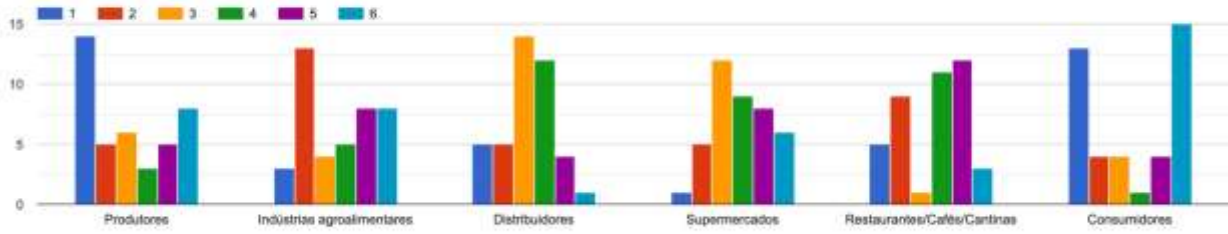


Figure 14. Survey results of users' interest about food waste.

The respondents ordered the relative importance of the (potential) sources of food waste quite differently (Figure 14). Producers were mostly viewed as “least important” (score of 1). The agri-food industries were considered less important (2). Similarly, distributors and supermarkets were also ranked less important (3). Intriguingly, restaurants/cafes/cafeterias were considered less important (2) and more important (4-5), while consumers were ranked “least important” (1) and “most important” (6).

Ordene, de 1-Menos importante a 6-Mais importante, as seguintes fontes de desperdício alimentar.



Sort, from 1-Least important to 6-Most important, the following sources of food waste.

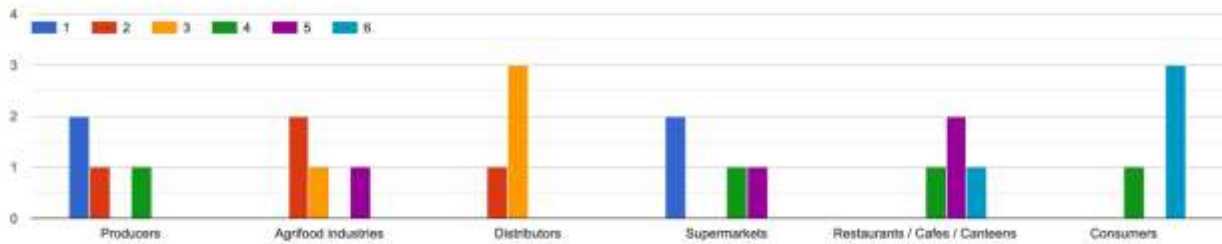
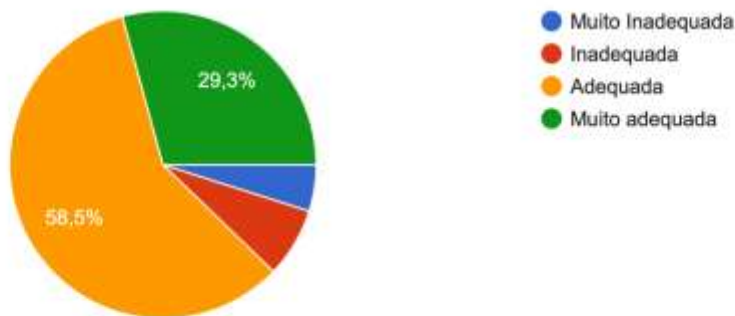


Figure 15. Users' perception on sources of food waste

When asked about the amount of food served in the canteen in the Campus da Penha, most of the respondents (approximately 89%) consider that it is “adequate” or “very adequate” (Figure 16). Notwithstanding, they estimate the percentage of food that is wasted per meal in the canteen to be between 11 and 30% (Figure 16). Interestingly, this projected range is in line with the estimates obtained thru sampling (see above all the values of overall food waste in the canteen).

Na sua opinião, a quantidade de comida servida na cantina é:

41 respostas



In your opinion, the amount of food served in the canteen is:

4 respostas

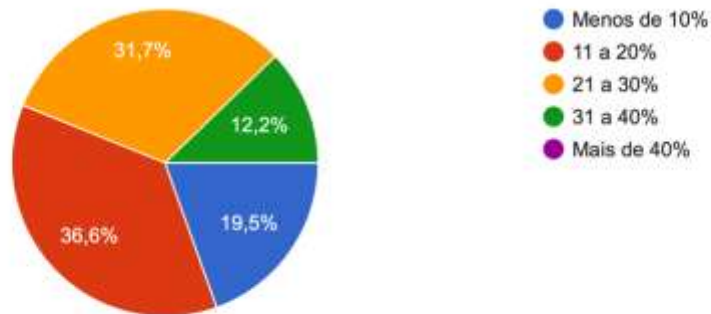


Figure 16. Users' opinion on the amount of food served

About 66% of Portuguese respondents had no idea where their food waste goes. Food waste is disposed of in landfills, incineration, or composting, according to 33.2% of Portuguese respondents. When participants were asked how important food waste is in their nations, 43% of Portuguese participants said it is very important. Furthermore, in another study when consumers were asked how they felt about food waste in their homes, with 45.9% of Portuguese respondents responding that they felt extremely responsible (Papaj, 2016).

Que percentagem de alimentos estima que é desperdiçada, em média, por refeição na cantina?

41 respostas



What percentage of food do you estimate that is wasted, on average, per meal in the canteen?

4 respostas

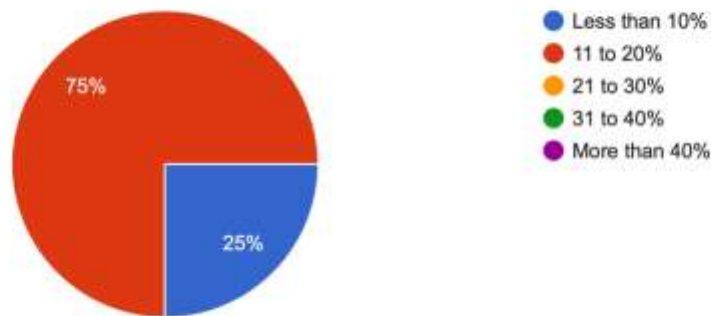


Figure 17. Users' assumption on amount of food waste percentage

Finally, respondents were asked to suggest actions, activities, procedures, etc. to reduce food waste in an open question. Answers included:

- Serve less food per plate.
- Allow users to take home the leftover(s) (since the COVID-19 pandemic this is more common together with the take-away system that was set up in UAlg)
- Promote the use of the pre-ordering system already in place in UAlg.
- Hand over the uneaten meals to food sharing platforms (such as Too good to go or Re-Food; this is already done in UAlg)

Similarly, when Abdelaal et al. (2019) questioned the students in Education City, a campus managed by Qatar Foundation (QF) why there was so much food waste in the canteen, students emphasized the importance of food quality, together with other solutions such as cost based on food quantity; eventually, more “a la carte” options; the use of pre-ordering to allow chefs to accurately cook quantities (or meals per day); and active rating feedback to assist chefs with selecting popular dishes.

There is a need to expand the sample size pertaining to these results from the survey, because there were only 46 respondents who completed the questionnaire. The size of a sample impacts two statistical properties: 1) the precision of our estimations and 2) the power of the study to make conclusions. Although sampling error is unavoidable, it can be decreased by increasing sample size. A lower margin of error is linked with larger samples. In a future application of such a questionnaire/survey and considering the number of students enrolled in UAlg (ca. 9000) augmenting the sample size to 369 respondents would increase the representativeness and benefit validity of conclusions (cf. <https://pt.surveymonkey.com/mp/sample-size-calculator/>).

As can be seen from all these figures, edible meal waste for each category of meal type is considerably greater than non-edible meal waste. This may be described as all these wastes constitute food waste that might have been avoided. As a result, any solution that can reduce food waste should be implemented.

Some general measures to decrease food waste

Food waste has become a worldwide embarrassment in recent years. Various best practices and recommendations for minimizing food waste, with a focus on the often-overlooked cost of waste in terms of natural resource usage and, as a result, the environmental advantages of decreasing that waste (Tobergte et al.,2013).

Reduce. Because food production has such a large impact on natural resources, and this impact grows as food moves up the food value chain, decreasing food waste is by far the most effective means of reducing natural resource waste. If the supply-demand balance can be better adjusted on the front end, for example, it means not utilizing natural resources to produce food in the first

place, reducing pressure on natural resources and allowing them to be used for other reasons (Tobergte et al.,2013).

Reuse. The greatest choice in the case of a food surplus is to keep it in the human food chain. This may entail finding secondary markets or donating it to feed the poor, to preserve its original purpose and save the usage of more resources to generate more food. If the food is unfit for human consumption, the next best alternative is to redirect it for livestock feed, saving resources that would otherwise be needed to manufacture commercial feedstuff (Tobergte et al.,2013).

Recycle/Recover. By-product recycling, anaerobic digestion, composting, incineration with energy recovery, and rendering are the primary recycling and recovery alternatives. All these solutions allow for the recovery of energy or nutrients, which is a considerable benefit over landfill (Tobergte et al.,2013).

Landfill. Landfilling organic waste releases gases like methane (a strong greenhouse gas) and pollutes soil and water, not to mention odor and other societal annoyances. Landfills should only be used as a last resort for food waste disposal, especially given the growing shortage of land for Earth people (Tobergte et al.,2013).

Reduce

Measures for reducing food waste

- Increasing public awareness of food waste
- Creating public relations campaigns
- Food waste audits should be encouraged
- Improving communication throughout the supply chain to better match food demand and supply
- Improving institutional organization
- Improving communication amongst the many supplies chain stakeholders
- Improving the harvesting, storage, processing, transportation, and retailing of food
 - Improving harvesting and post-harvest storage practices
 - Techniques for processing improvements

- Enhancing public transit
- Improving the retail industry
- Improving food service quantity planning
- Changing consumer behaviors
- Legislative Actions

Suggestions for reusing food waste

- Creating markets for items that would otherwise be discarded from the food chain
- Redistributing food to the ones in need
- Food that is unfit for human consumption is fed to cattle

Measures recycling, and repurposing

- Creating food from trash and by-products
- Anaerobic digestion

Food waste is microbiologically broken down in confined containers in the absence of oxygen in anaerobic digestion. The process yields two primary products: digestate, which may be used as a fertilizer instead of fossil fuel-based fertilizers, and biogas, which can be used to create car fuel, heat, or power, or processed and directly fed into the gas grid. Depending on the plant location, each of these products has a varied level of environmental value and may be exploited. Anaerobic digestion is, in any event, environmentally superior to composting because it produces both digestate and biogas (DEFRA (b), 2011).

Composting

Composting can turn a wide range of organic waste materials into a valuable finished product with a few advantages, including saving money by conserving water in the soil and reducing the need for commercial fertilizers, improving soil health, preventing soil erosion, and raising awareness about the amount of food wasted (Tobergte et al., 2013).

Rendering

Rendering is a treatment method that involves heating food waste and other animal by-products to a high temperature, often under pressure, to eliminate moisture and make it easier to separate the tallow (fat) from the protein components. Tallow may be used to make tires and paint, as well as animal feed, fertilizers, and fuel in modest quantities. The protein portion can be dried and utilized as a protein source in pet food and as a fuel, subject to animal by-product restrictions (Tobergte et al., 2013).

Landfilling

Landfilling should only be used as a last option because it has several severe environmental, societal, and economic consequences. However, it is still the most used method of garbage disposal across the world. Landfilling can involve burying or dumping trash, both of which have a negative impact on the environment compared to incineration. The main source of GHG emissions from the waste industry is methane emissions from landfills, which contribute about 700 Mt CO₂ eq (UNEP, 2010). Incineration has a low worldwide environmental effect when compared to landfilling, contributing about 40 Mt CO₂ eq (Tobergte et al., 2013).

Conclusion

Plate waste, or leaving a piece of a meal uneaten, is a major problem for food services like school dining halls. At home, at restaurants, and elsewhere, customers leave portions of their meals on their plates. On the contrary, there are almost 800 million poor people in the globe who are starving.

This study was conducted in an experimental setting, with the goal of determining how much waste occurs in public consumption areas. The research focused on preparation/cooking waste and post-consumption waste, with the former being classified as edible and the latter as non-edible food, from the canteen on campus de Penha, which served daily lunch and dinner to an average of 1200 people of various socioeconomic and age groups.

We were able to pinpoint the source by determining the proportional amount of food waste created by category of food product and type of food waste generated. The online survey, on the other hand, assisted us in (preliminarily) understanding consumers' perspectives on food waste and food waste created by UAlg's canteen.

Food waste per item during the preparation stage ranged from 1% (fish) to 78% (collard), with an overall wastage rate of 9%. The only raw material products that generated no waste were turkey and pork.

There were 483 meals examined, with the number of economical and full meals being 252 and 231 respectively, and the types of main dishes being 206, 173, and 104 for meat, seafood, and vegetarian meals, respectively. Meat variety was preferred for economical meals, followed by seafood and vegetarian, while seafood was popular for full meals, followed by meat and vegetarian.

In general, the average percentage of waste generated by consumers per item of meal (soup, dish, salad, and dessert) ranges from 11 % for soup, to 21 % for the main dish, to 24 % for salad.

The above-mentioned categories were further separated into edible and non-edible fractions for food waste created by consumers in the canteen. The percentage of edible food waste in total food

waste from the two types of meals was 62 % for economical meals and 63 % for full meals. Similarly, edible waste percentages were 74 %, 62 %, and 69 % for meat, seafood, and vegetarian dishes, respectively. In terms of edible meal waste, vegetarian dish waste was found to be higher than seafood and meat dish waste, with 93 %, 68 %, and 62 % for economical meals and 91%, 57 %, and 76 % for full meals, respectively. This high proportion of edible portion waste in every category clearly underlines the importance of SAS UAlg promoting the procedures/systems already in place and consider implementing alternative solutions that can decrease food waste as quickly as possible in the canteen.

Based on this, the canteen management team should consider implementing some of the food waste reduction methods, such as increasing supply chain communication to better match food demand and supply, and improving food service quantity planning, among others. Meanwhile, SAS UAlg could devise an “education” campaign, e.g. publicizing the results obtained in this study, urging users (UAlg students and staff) to change their eating habits in order to decrease food waste, along with the possibility of establishing a food sharing platform within UAlg premises as an impending initiative.

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