Food waste management in ethnic food restaurants

Running title: **The case of Chinese cuisine in the UK.**

Abstract

The foodservice sector generates excessive amounts of food waste. This wastage remains however understudied, especially in the context of specific foodservice sub-sectors catering for a large number of consumers. This holds true for ethnic food restaurants holding a noticeable share of the global out-of-home food consumption market. This paper contributed to knowledge with an exploratory study of food waste and its management in Chinese cuisine restaurants operating in the UK. By applying a novel approach to estimating food waste in foodservice operations, it demonstrated the magnitude, established the drivers and revealed managerial approaches to food waste mitigation. The study showcased the role of contextual, UK market-specific, and cultural, ethnic cuisine-related, factors in food waste generation and its management. Drawing upon perspectives of foodservice operators, the study outlined the key barriers to more effective mitigation of food waste and proposed how these could be at least partially overcome in the future.

Keywords

Food waste; foodservice provision; ethnic food; Chinese cuisine; United Kingdom

Highlights

- A novel approach to estimating food waste in foodservice operations
- A case study of Chinese cuisine restaurants in Bournemouth, United Kingdom
- A Chinese cuisine restaurant wastes up to 0.138 kg of food per guest
- In total, this translates to almost 15 tonnes of wasted food per business per year
- Wastage is driven by UK market- and Chinese cuisine-specific factors

1. Introduction and background

The United Nations have recognised food waste as a societal challenge of global significance given that it compromises the (business and environmental) sustainability of the food supply chain, contributes to food insecurity and accelerates social inequality (Parfitt *et al.* 2010). Food waste is unacceptable not only from the environmental and socio-economic perspectives, but also from the moral viewpoint (Martin-Rios *et al.* 2018). Wasting food in presence of 820.8 million hungry people (11% of the global population in 2017; data from WHO 2018) represents an unaffordable luxury and urgent measures are required to reduce wastage and/or divert wasted food to feed the people in (greater) need (Vlaholias *et al.* 2015).

The foodservice sector makes a noticeable contribution to global food wastage. In the EU-28, foodservice operations account, on average, for circa 12% of wasted food across this region's food supply chain (FUSIONS 2016) while the share of 25% has been reported for the USA (ReFED 2018). The foodservice sectors of developing and transitional economies are even more wasteful (COMCEC 2017) as, for example, the figure of 50% has been cited for China (Wen *et al.* 2018).

Food wastage in global foodservice operations is of particular concern because the measures that have been applied to-date to reduce its occurrence have only had limited effect. For example, WRAP (2020) reports that, within the period of 2015-2018, the UK's foodservice sector has increased its food wastage by 7.5% while most other segments of the national food supply chain have reduced the amounts of wasted food. Food consumption out-of-home is growing in popularity in the UK (Mintel 2020), but also globally (Filimonau and De Coteau 2019), thus highlighting the need for urgent interventions to mitigate the related growth in food wastage. This is especially important because about 75% of

food wastage produced in the foodservice sector is represented by a so-called ‘avoidable’ fraction, or the food which was edible at the point of its disposal, such as any surplus dishes and/or any customer plate leftovers (WRAP 2013a). Only in the UK this wastage costs foodservice providers circa £2.5 billion in lost revenues and generates 2.7 million tonnes of CO_2-eq., thus presenting a strong business and environmental case for its reduction (WRAP 2018).

Despite of excessive food wastage within the foodservice sector, its phenomenon remains understudied (Principato *et al.* 2018). Although scholarly interest in understanding the magnitude, establishing the drivers and identifying the approaches to food waste mitigation in foodservice operations is gradually growing, both the scope and the scale of analysis are limited (see Filimonau and De Coteau 2019 for a detailed review of extant studies on the topic in question). Partially, this is attributed to the known issues with primary data collection (Filimonau *et al.* 2019b) whereby foodservice operators demonstrate reluctance to collaborate with academics on such sensitive topic as food wastage (Filimonau *et al.* 2020a). Although scholarly research can inform food waste reduction practices, thus cutting operational costs and saving business resources, foodservice operators fear potential reputational damage imposed as a result of disclosing data on the amounts of food wasted on their premises (Sakaguchi *et al.* 2018). Securing consent of foodservice providers to partake in scholarly research on food waste can therefore be difficult (Eriksson *et al.* 2019).

The lack of cost-effective approaches to accurately quantify the amounts of wasted food in foodservice operations is another barrier to scholarly research. Food waste audit in a commercial enterprise is laborious whilst most foodservice providers cannot assign a dedicated member of staff to record food wastage due to staff shortages and busy nature of foodservice operations (Filimonau *et al.* 2020a). Same reasons, coupled

with the industry's reluctance to collaborate with academics highlighted above, explain why presence of a researcher in the restaurant's kitchen with food waste audit purposes is not always feasible. Although technological solutions have emerged that can aid foodservice providers in measuring the amounts of wasted food (see, for example, Winnow 2020), these remain expensive and can only be afforded by large, chain-affiliated, foodservice operators or institutional eateries financed from the public budgets, such as hospital and/or school canteens. As the majority of foodservice operators are represented by small-to-medium sized enterprises (Eurostat 2019), the uptake of technology for food waste quantification has been slow to-date. To partially overcome this issue, some national authorities, government-affiliated 'think tanks' and/or charitable organisations have developed practical guidelines on how to measure food wastage in foodservice operations. For example, WRAP (2015) has designed a simple food waste tracking sheet for UK restaurateurs, thus enabling them, with certain generalisations and approximations, to estimate the amounts of wasted food in their operations. Although such simple, down-to-earth, solutions are much needed, their commercial uptake remains limited whilst their effectiveness has never been assessed.

The complexity and diversity of the foodservice sector represents another impediment to the related scholarly research on food waste (Papargyropoulou *et al.* 2016). Past studies have looked at the different categories of foodservice providers, such as institutional eateries and contract caterers (hospital and work canteens) (see, for example, Pinto *et al.* 2018 and Williams and Walton 2011), full-service (Filimonau *et al.* 2020b), casual dining (Tatano *et al.* 2017), fine-dining (Charlebois *et al.* 2015), and quick-service (Abad *et al.* 2015) restaurants. Past research has further considered food wastage within an aggregated sector of hotels, restaurants and cafes (HoReCa) (Wang *et al.* 2018), thus offering a generalised perspective across the board. While such studies are useful and much needed, in order to provide a (more) comprehensive

understanding of the phenomenon of food waste in the foodservice sector, they should be supplemented with more (targeted) research (Principato *et al.* 2018). It is argued that this research should aim at: (1) covering specific sub-sectors of foodservice that have not yet been studied to-date but are prone to waste food, such as cruises and street food vendors; (2) investigating particular occasions of out-of-home food consumption that hold potential to generate excessive wastage, such as at business (conference) and social (festival) events; and (3) examining specific types of eateries, such as pubs, takeaways or ethnic food restaurants, that are all popular places to consume food in the out-of-home settings but whose food wastage patterns have never been established. Although popular media, trade publications and the 'grey' literature have reported excessive food wastage occurring in the above contexts of eating out (see, for instance, Keynes 2019 for festivals; Ros 2019 for cruises; WRAP 2013a for pubs), scholarly research is urgently required to confirm (or deny) the above claims by providing (more) empirical evidence and, most importantly, to aid in the design of mitigation solutions.

Extending the geographical scope of research is also required (COMCEC 2017). Academic studies on food waste management in the foodservice sector of developed countries are gradually growing in number (Filimonau and De Coteau 2019). What is alarming is that, with a few notable, very recent, exceptions (Kasavan *et al.* 2019; Papargyropoulou *et al.* 2019; Wang *et al.* 2017), the foodservice sectors and the national cuisines of most developing and transitional economies have largely been excluded from analysis (Filimonau *et al.* 2020c). It is argued that a better understanding of the phenomenon of food waste in the different sectors and sub-sectors of foodservice operations, on different occasions of out-of-home food consumption, in different food consumption markets and within different national cuisines is a necessary attribute

of identifying the main drivers and revealing the key repercussions of wastage with a consequent design of effective measures to minimise their occurrence.

This paper contributes to knowledge with an empirical study of food waste and its management in ethnic food restaurants in the UK, using Chinese cuisine as a case study. Ethnic food is understood in the context of this research as *any foodstuffs originating from a heritage and culture of a particular ethnic group or a specific country that are culturally and socially accepted by consumers outside of the respective ethnic group and/or country of origin* (Kwon 2015). Examples of foodservice providers of ethnic food in the UK are therefore represented by restaurants providing dishes that originate from the non-UK cuisines, such as Italian, Mexican or Chinese, to mention a few. Besides the general lack of scholarly research on the phenomenon of food waste within the UK foodservice sector (Filimonau *et al.* 2020b), there are two other important reasons for why this study focuses on ethnic food restaurants.

First, out-of-home consumption of ethnic food in the UK was worth £12.6 billion in 2019, thus occupying a noticeable share of more than 10% within the national foodservice market (Mintel 2020). By 2025, this value is forecast to grow by circa 8% which is substantially higher than the sector's average of about 3% (MCA Insight 2016). Consumption of ethnic food in the UK is anticipated to be a leading market trend in the foreseeable future, given its continued popularity with Generation Y customers (Mintel 2020). It is fair to suggest that this growth will come at a cost of food wastage, thus highlighting the need for its better understanding.

Second, ethnic food restaurants are unique in that, whilst being based in the UK market, they exemplify features of their native cuisines, including the use of special ingredients, traditional cooking techniques and particular serving methods (Jang *et al.* 2012). For example, Chinese

cuisine, understood herewith as an aggregate of the *'eight major cuisines'* of China (Zhang and Ma 2020), utilises large amounts of vegetables, starchy foodstuffs (rice and wheat) and aquatic products in cooking which results in their excessive wastage (Wang *et al.* 2017). Although some foodservice operators choose to modify their ethnic cuisines to ensure they can better appeal to the local consumption market, most tend to retain the authentic features (Chhabra *et al.* 2013) as they cater not only for the locals, but also the expatriates. Further, authenticity is a major attraction of ethnic food, meaning many of its foodservice providers tend to stick to the food preparation and provision standards adopted at home (Youn and Kim 2017). This raises a number of interesting research questions. Given that the foodservice sector of China generates circa 50% of its national food wastage (Wen *et al.* 2018), does this excessive food waste occur because of the native/cultural traditions of food preparation and consumption as shown by Filimonau *et al.* (2020c)? Or, is it attributed to the contextual/environmental factors of the UK's market of out-of-home food consumption, such as difficulties in demand forecasting, inflexible suppliers, cooking inefficiencies and irresponsible consumer behaviour (Filimonau *et al.* 2020b)? Perhaps, both factors contribute to wastage but the extent of this contribution and its consequences remain unclear as no academic research has been undertaken on this topic to-date.

This study has set to shed light on the phenomenon of food wastage in ethnic food restaurants in the UK specialising in Chinese cuisine by answering the following research questions: (1) how large is food wastage in Chinese cuisine restaurants in the UK? (2) what are the main drivers of wasted food? (3) what approaches, if any, do managers of Chinese cuisine restaurants apply to mitigate food waste occurrence? In addition, given the lack of cost-effective methods for auditing food waste in foodservice operations, this study introduces and tests the viability

of a novel approach to quantify and characterise food wastage. It shows the benefits of adopting this approach over the currently available alternatives.

2. Materials and methods

The study focuses on ethnic food restaurants specializing in Chinese cuisine given its top popularity in the UK market of out-of-home food consumption. According to Mintel (2020), 34% of UK residents regularly eat out in a Chinese restaurant and 48% routinely order Chinese takeaways. This has made Chinese cuisine the most popular type of oriental cuisine in the UK with 94% customers of oriental restaurants giving preference to those with Chinese specialism (Wing Yip 2016). To answer its research questions, the study adopted the multi-stage research design underpinned by the use of mixed methods and a case study approach (Figure 1).

[Insert Figure 1 here]

2.1.Quantitative stage: obtaining benchmark data via a food waste audit

To benchmark food wastage in Chinese restaurants in the UK, a case study method was utilised as proposed by (Yin 1989). Case studies enable researchers to gain a first-hand understanding of the phenomenon of restaurant food waste by observing and evaluating its occurrence on the ground, thus being a popular approach to study food wastage and its management in the foodservice sector (see, for example, Charlebois *et al.* 2015; Papargyropoulou *et al.* 2019; Silvennoinen *et al.* 2015). Case studies represent a popular method in food waste research conducted in the

context of commercial foodservices, as per above, but also contract catering (Eriksson *et al.* 2017), agriculture (Johnson *et al.* 2018), retail (Eriksson *et al.* 2015) and households (Suthar and Singh 2015). This is because case studies are capable of shedding light on previously unexplored research topics and can be used to examine issues of sensitive business nature, such as food waste with its significant detrimental effect on restaurant's corporate image and profitability (Matthews and Ross 2014). Limited generalisability and restricted representativeness of results is a known, major, drawback of the case study method (Beeton 2005). This notwithstanding, it is deemed to be 'fit for purpose' when collecting primary data in the research contexts characterised by long-established difficulties in the recruitment of study informants, such as food waste and its management in foodservices (Filimonau *et al.* 2019b). The negative effect of limited generalisability and representativeness of the case study method will be partially reduced in this study by validating the primary, benchmarking, data collected in a case study restaurant with senior managers of other ethnic cuisine restaurants as explained below.

To this end, a Chinese restaurant located in Bournemouth, a seaside town in the southwest of the UK with the population of circa 195000 residents (data from 2017, BCP Council 2018), agreed to provide researchers with access to its back-of-house operations with the purpose of auditing the magnitude of food wastage and its flows. The case study restaurant had (1) operated under current management for over ten years; (2) was open daily for lunch and dinner service; and (3) had the capacity of 105 seats; thus falling into the category of 'medium-to-large' sized foodservice providers. The case study restaurant offered 'a la carte' food service and did not offer takeaways. According to the management team, the customer base of the case study restaurant was represented almost equally by the Chinese expatriates living in Bournemouth and

customers of the non-Chinese origin. Most guests were repeat customers. The case study restaurant's accounting records suggest that, in 2018, it catered for circa 107000 guests, which translates into about 290 guests a day, on average.

The amounts of wasted food were measured by the method of direct weighing (Wang *et al.* 2017). Due to its better accuracy, this method was preferred to the method of managerial self-assessment which would involve interviewing restaurant managers and/or chefs with a request to estimate the magnitude of food wastage in their business premises (Filimonau *et al.* 2019a). The self-assessment method has limitations as, due to the issue of poor recall and social desirability biases (Filimonau *et al.* 2020a), but also because of poor visualisation of food waste flows in foodservice operations (Derqui *et al.* 2018), it may prompt managers to either provide no exact figures on food wastage or to under-estimate the actual amounts of wasted food. However, the self-assessment method is cheaper and less laborious to implement and, hence, it was adopted in this study to cross-validate the benchmarking results of the food audit undertaken in the case study restaurant (see Figure 1 and detailed explanations in Section 2.3).

The food waste tracking sheet developed by WRAP (2015) for the UK foodservice sector was adopted for food waste auditing purposes but refined to better fit the context of foodservice provision. WRAP (2015) suggests that foodservice providers should record the amounts of wasted food in their ventures during at least three typical days of their business operations. WRAP (2015) subsequently recommends that the amounts of wasted food recorded in the result of such audit are extrapolated to estimate the magnitude of food wastage over a longer period of business operations. For example, the total amount of food waste generated by a foodservice operator per month can be established by

multiplying the three-day averaged value of wasted food obtained from the audit by 30. Subsequently, the amount of annual food wastage can be obtained by multiplying the monthly amount by 12.

It is argued that the food waste tracking sheet developed by WRAP (2015) needs to be refined to better reflect upon the complexity of foodservice operations. From the managerial perspective, the key challenge of the auditing method recommended by WRAP (2015) is to identify the three days of their operations that can be classified as 'typical'. This is highly problematic as consumer demand for food is characterised by substantial (seasonal, monthly and weekly) variations (Filimonau and De Coteau 2019). To overcome this challenge, thus refining the food waste tracking method proposed by WRAP (2015), this study opted to record food wastage in the case study restaurant at the end of each working day in the course of the entire month of July 2019 (Table 1).

[Insert Table 1 here]

Figure 2 shows the daily pattern of food waste generation in the case study restaurant. It demonstrates that most food waste is produced on Friday, Saturday and Sunday as these are the traditionally popular days for eating out. Importantly, Figure 2 indicates one important possible drawback of the WRAP (2015) method which relates to the definition of three 'typical' days of business operations. Indeed, should a restaurant manager define Friday-Sunday as 'typical', with a subsequently extrapolation of food wastage across the month, then this would result in the over-estimation of the actual amount of wasted food in their business premises. In contrast, should a restaurant manager assign 'typical' operations to other days of the week (for instance, Monday-Wednesday), then this would bring about an under-estimate of food wastage. Further, Table 1 shows that recording food waste for one week and then extrapolating it to obtain a figure for the entire month may be inaccurate as there

are substantial variations in food wastage in different weeks of operations (compare, for example, Week 1 and Week 2). Thus, this study shows that auditing food waste for the entire month is more precise and reliable than for three days, or one week, of business operations only.

[Insert Figure 2 here]

Importantly, the choice of the month of July for auditing food wastage in the case study restaurant was deliberate because summer was traditionally characterised by high demand for out-of-home food consumption in the UK (Filimonau *et al.* 2020b). Food waste audit in one of the 'busiest' months of restaurant business operations enabled subsequent extrapolations to estimate food wastage across the entire year. This was done at the next stage of this study.

2.2.Qualitative stage I: benchmark data validation

The food waste audit data were presented to the case study's restaurant owner and head chef for validation. They were requested to double-check the data and subsequently confirm or deny if the amounts of food wastage recorded were 'typical' for the month of July of their business operations. This was done to eliminate the undesirable effect of any 'outliers' such as, for example, any special events which the case study restaurant may have catered for in the month of July 2019 and/or any unanticipated falls and/or rises in consumer demand for food in the month concerned. The management team of the case study restaurant confirmed that the food wastage data of July 2019 were 'typical' for this month of their business operations.

Following data validation, the owner and head chef were requested to estimate, using the validated benchmark data from the month of July 2019 and reflecting upon their extensive work experience of running the case study restaurant, the amounts of food wasted in their business premises in other months of the year. Due to the issues of poor recall, the study did not seek to obtain the figures of the highest precision; instead, the management team were asked to roughly estimate the extent to which the July's food wastage differed, if at all, from food wastage occurring in other months of business operations. The estimates were made on a percentage basis compared to the benchmark month of July which was set at 100%. For example, food wastage in August was 120% of that in July and food wastage in January was 70% of that in July (Table 2). It is argued that this simplified approach to estimating the amounts of wasted food in foodservice operations is as cost-effective but, concurrently, more accurate, than the WRAP's (2015) food waste tracking sheet.

[Insert Table 2 here]

2.3.Qualitative stage II: cross-validation of benchmark data via managerial interviews

Following the food waste audit and its validation in the case study restaurant, interviews with owners and head chefs of other Chinese restaurants in Bournemouth were conducted. The interviews aimed to (1) present the benchmarking results of the annual food wastage from the case study restaurant to other restaurant managers in order to establish how these compare to the amounts of food wasted in business premises of other Chinese restaurateurs. For better comprehension, the benchmarking data were presented to managers in kg, but also using the food waste bin capacity, i.e. the number of 25-kg bins daily provided by restaurants for collection by municipal waste disposal services and/or private waste

collectors. The interviews further strove to (2) shed light on the main drivers of food wastage in the Chinese restaurants across the sample and (3) provide insights into the managerial approaches employed for its mitigation.

Interview participants were recruited from among the Chinese restaurants in Bournemouth listed on TripAdvisor. For better consistency and generalisability of this study's findings, recruitment only targeted the Chinese restaurants serving 'a la carte' food, rather than Chinese takeaways. It was assumed that, in takeaways, kitchen operations were the only source of food wastage, implying that a comparative analysis of the food waste audit's results undertaken in the case study restaurant (which combines food wastage from kitchen operations and customer plates, see Table 1) would be unviable to conduct. On 1st July 2019, TripAdvisor listed 34 foodservice operators in Bournemouth specializing in Chinese cuisine, where 16 represented restaurants. The management teams of these restaurants were approached with a request to partake in interviews. Upon detailed explanation of the project's goals and reassurance in anonymity of its findings, the owners and head chefs of ten Chinese restaurants provided participation consent. The size of the restaurants under study ranged from small to large (Table 3), thus offering a useful insight into the phenomenon of food wastage across a broad sample of foodservice businesses specializing in Chinese cuisine.

[Insert Table 3 here]

For managerial interviews, the study adopted an interview protocol which was pre-tested and validated in past research on food waste and its management in the foodservice sector (Filimonau *et al.* 2019a). The interviews took place in August 2019 and lasted, on average, 40 minutes; they were digitally recorded and transcribed verbatim. Interview transcripts were analysed thematically with members of the research team reading the transcripts carefully and then coding and labelling the material compiled in line with the guidelines provided by Braun and Clarke

(2006). The final coding table (Table 4) was a product of consensus reached by all members of the research team seeking to achieve consistency in interpretation of the interview material, thus ensuring data trustworthiness (Schutz 1973). Verbatim quotations representative of all major themes were employed when writing the outcome of thematic analysis up to better support the study's findings.

[Insert Table 4 here]

3. Results and discussion

3.1. Benchmarking data - quantity and character of food waste

Within a year of business operations, it is estimated that the case study restaurant generates 14.75 tonnes of food waste (Table 2). Given that, in 2018, the case study restaurant catered for circa 107000 guests (see Section 2.1), and assuming that this pattern remained unchanged in 2019, then food wastage in the case study restaurant equates to 138g per guest. Table 5 demonstrates how this compares against figures on food waste reported in past studies. It shows that the case study restaurant wasted more food than various categories of commercial and contract catering foodservices in Sweden, Switzerland and China. Comparable quantities of wastage were recorded in Finland and Italy but per portion and per meal, respectively, rather than per guest. Lastly, the figure obtained in this study is considerably lower than the estimate of the Sustainable Restaurant Association (SRA 2010). However, the latter figure is dated and representative of the entire UK foodservice sector which is considerably more diverse. Same holds true for a figure reported in Sweden by Engstrom and Carlsson-Kanyama (2004) which reflects a study

conducted over a decade ago. The estimate obtained in the current study is further significantly lower than food wastage recently recorded in a Chinese cuisine restaurant in Malaysia (600g per guest, Papargyropoulou *et al.* 2019) which can be partially attributed to cooking inefficiencies observed in the case study restaurant of the latter study. Importantly, assuming that an average restaurant meal in the UK weighs between 450 and 860g (WRAP 2013b), then food wastage in the case study restaurant constitutes about 16-31% of a meal.

[Insert Table 5 here]

Food wastage is characterised by substantial weekly, monthly and yearly fluctuations (Table 1 and 2, Figure 2). The last three days of the week (Friday-Sunday) account, on average, for 60% wastage which is due to people's desire to celebrate the end of a working week by eating out. Within a month, most wastage happens in the first and last week which is likely to be a matter of affordability. With paydays in the UK normally falling onto the last week of the month, people tend to spend money on eating out at around this time whilst attempting to save money in the middle of the month. Lastly, most food wastage occurs in the 'high' seasons of July-August (warm summer time) and November-December (Christmas festive season) which is in line with past research (Charlebois *et al.* 2015; Pirani and Arafat 2014; Tatano *et al.* 2017). However, a distinctive feature of this study is a small peak in food wastage recorded for February (Table 2). This is attributed to the celebration of the Lunar New Year (Spring Festival) and St. Valentine's Day with all Chinese restaurants running promotions and special festive menus over this period.

Rice, noodles, vegetables, meat and seafood represent the most wasteful food fractions (Table 1) which is in line with Wang *et al.* (2017) but contradicts (Filimonau *et al.* 2019b; Papargyropoulou *et al.* 2019; Pirani and Arafat 2016) where substantial wastage of fruits and vegetables,

potato and bakery items was recorded. This demonstrates the national cuisine effect given starchy foodstuffs and fresh vegetables are popular ingredients in Chinese cooking. Kitchen and customer plates make an almost equal contribution to food wastage in the case study restaurant (Table 1). Interestingly, however, is that customer leftovers contribute to excessive food wastage over weekends, when the public demand for food is the highest. In contrast, the restaurant kitchen wastes most food during weekdays, which is largely due to poor demand forecasting and subsequent overproduction.

3.2.Benchmarking data – cross-validation

Interview participants largely confirmed the benchmarking data. No one described their food wastage as being larger of that in the case study restaurant (Table 4). This may be partially attributed to social desirability bias with restaurateurs unwilling to admit wasting more food than the others (Filimonau *et al.* 2019b). A number of interview participants estimated their food wastage as being smaller than that of the case study restaurant, but all these businesses had a smaller seating capacity (see Restaurant ID 3-6, Table 3) and, hence, it would be fair to suggest that they wasted less food. Concurrently, the majority described their food wastage as being 'comparable' to the figure recorded in the case study restaurant. Even with a potential effect of social desirability bias, which might have prompted some restaurateurs to agree to the benchmarking data from the case study restaurant rather than to acknowledge higher wastage, this finding pinpoints potentially substantial cumulative magnitude of wasted food in Chinese restaurants in the UK, thus calling for its urgent mitigation.

Similar to the benchmarking data, interview participants highlighted rice, noodles, fresh vegetables, meat and seafood as most wasted foodstuffs in their business operations (Table 4). Interestingly, however, is that sauces and cooking oil were mentioned as two additional foodstuffs with excessive wastage. This is well explained by the quote below:

> *'In the kitchen, chefs use a lot of oil to cook as this is what the Chinese food is about, it's oily and greasy. We cannot re-use this oil and, so, it makes a lot of our waste. Sauces is another thing. We use a lot of them as they're key to the Chinese kitchen. So, there's no surprise, we waste a lot of sauces too… Also, in the pantry, where the staff prepare side dishes, they sometimes put too much salad on a plate, more than the customer needs. This is to keep the customer happy and to make the dish look bigger and nicer…'* (Restaurant 2)

Such sauces and cooking oils as rice vinegar, hoisin sauce, soy sauce, fish sauce, plum sauce and sesame oil represent one of the key ingredients in many Asian cuisines, being widely used for cooking and serving food (Trang 2010). Concurrently, many authentic Chinese dishes are prepared by a method of deep-frying in cooking oil. This is a distinctive finding of this study attributed to the peculiarity of ethnic (Chinese) food preparation as past research did not reveal excessive wastage of sauces and cooking oil in foodservice operations (Charlebois *et al.* 2015; Tatano *et al.* 2017; Wang *et al.* 2018).

3.3.Main drivers of food wastage

Chinese restaurants waste most food in preparation and in the form of plate leftovers (Table 4). This is in line with past research which has established cooking processes and customer eating patterns as main drivers of food wastage in casual dining (Tatano *et al.* 2017) and fine-dining (Charlebois *et al.* 2015) restaurants based in Europe, but also in Chinese restaurants based in Malaysia (Papargyropoulou *et al.* 2019) and China (Filimonau *et al.* 2020c; Wang *et al.* 2017; Wang *et al.* 2018). This suggests that ethnic food restaurants share a number of similarities with other types of restaurants in the UK, but also abroad, in terms of the food waste drivers. This is equally attributed to the authenticity of Chinese cuisine which requires application of special, often wasteful, cooking techniques (Filimonau *et al.* 2020c), but also to such contextual factors as irresponsible consumer behaviour, often accelerated by the effect of the Chinese dining culture (Wang *et al.* 2018). For example, when eating out in groups, the Chinese tend to order more food than required to demonstrate hospitability and generosity towards their guests (Liao *et al.* 2018). This finds reflection in excessive wastage, as per below:

> *'Although our chefs have years of experience, they don't always care about food wastage as a good Chinese dish requires nice cuts. If the dish doesn't look or taste great, it goes straight to the bin… Also, food wastage comes from customer plates because we cannot control it as it comes from a personal decision to eat or not to eat the food. It's business, you cannot stop customers ordering more even if you know they won't finish it all…'* (Restaurant 10)

A distinctive finding of this study was wastage due to imperfect food supply (Table 4). To prepare traditional Chinese dishes, restaurants should try and make use of fresh and authentic cooking ingredients. These can be difficult to procure given that the supply chains of ethnic foodstuffs are less established in the UK in comparison to other, more popular in the national food consumption market, food types (Oglethorpe and Heron 2013). Authentic foodstuffs may take longer to arrive, thus losing their quality; in addition, chefs may have high quality standards towards the cooking ingredients received from suppliers and reject those foodstuffs that do not meet their requirements. This is particularly true for the Chinese restaurants specializing in upmarket/fine dining (Wang *et al.* 2018):

> *'Although we tend to have rather frequent deliveries every Tuesday and Friday, the quality of vegetables and, especially, seafood is not always good enough according to our chefs. These often come unfresh or damaged because of the problems of transport. In this case, we have no choice but to dispose of them and order more…'* (Restaurant 5)

3.4.Approaches to mitigation

Demand forecasting was the most popular approach to managing food wastage in Chinese restaurants (Table 4) which is in line with previous research (Filimonau *et al.* 2019a; Hennchen 2019; Hu *et al.* 2004). All interview participants agreed that they would try and cook on demand,

rather than in advance and, even if this approach took more time to prepare meals, it could reduce food waste occurrence in the kitchen. Working with reliable suppliers to ensure frequent delivery of fresh foodstuffs on demand was another popular approach which is, again, in agreement with the literature (Charlebois *et al.* 2015; Mena *et al.* 2011; Pirani and Arafat 2016). Portion control was used by many to eliminate customer plate leftovers. However, unlike past research on the application of this method in foodservice (Betz *et al.* 2015; Pinto *et al.* 2018; Principato *et al.* 2018), Chinese restaurants tended to make use of extensive managerial experience in defining the 'right' size of the dish, rather than pro-actively encouraged guests to order less food at once but to place more frequent food orders:

> *'Look, our restaurant has been opened here for over 10 years, so we know this place [Bournemouth] and we know when it's going to be busy and when the restaurant is quiet. So, we try to cook only when the customers come. When customers order dishes, we send their orders to the kitchen, so the chefs only cook those amounts of food needed for this order, they don't cook anything in advance. And our chefs are experienced and have been working here for a long time, so they understand the standard of the portion which is best for our customers… We also work with our suppliers to ensure they deliver food we want and only when we want it'* (Restaurant 6)

Some interview participants used excess ingredients to cook meals for their staff (Table 4) which confirms the literature (Filimonau *et al.* 2020b; Filimonau *et al.* 2020c; Sakaguchi *et al.* 2018). However, unlike shown in past research (Sakaguchi *et al.* 2018), Chinese restaurants did not donate surplus food to the people in need. This was justified by the logistical and hygienic challenges, which is a long-established barrier to surplus food redistribution in the UK (Alexander and Smaje 2008), but also abroad (Chalak *et al.* 2018). Also, the issue of taste was mentioned as a potential constraint given the amount of spices used in preparing authentic Chinese dishes:

> *'The main problem with donations is transport. Chinese dishes are big, they contain a lot of sauce, it's very heavy. Also, if we decided to donate food, we'd need to store it in a correct way, so that it's all very hygienic and it doesn't produce germs, especially in the hot weather when the food can go off very quickly. Lastly, it's a matter of taste. Chinese food is spicy, and contains a lot of rice and veggies, so not everyone here [in the UK] likes it'* (Restaurant 8)

All interview participants agreed that disposing of food waste, including any surplus dishes and excess ingredients, was the easiest option from the managerial perspective. This is in line with findings from past research (Filimonau *et al.* 2019b; Papargyropoulou *et al.* 2019; Pirani and Arafat 2016) which underlines the need for the local and national government, but also other stakeholders of foodservice provision in the UK,

such as industry associations, to design measures encouraging restaurateurs to manage their food waste more pro-actively, thus diverting it from landfill.

3.5.Barriers to more effective mitigation

In conclusion, interview participants were requested to elaborate on the barriers towards (more effective) mitigation of food wastage in ethnic food restaurants in the UK (Table 4). The answers given were generally reflective of major contextual, local market related, challenges in managing food waste highlighted earlier in interviews. For example, poor consumer awareness of the negative impact of food wastage was repeatedly mentioned, which is in agreement with the literature (Filimonau *et al.* 2020c; Sirieix *et al.* 2017; Stöckli *et al.* 2018). The UK government was blamed for not doing enough to raise consumer awareness which, again, confirms past research findings (Filimonau *et al.* 2019b). Lastly, food waste mitigation was not considered a business priority which is in line with other studies (Filimonau and De Coteau 2019; Martin-Rios *et al.* 2018; Priefer *et al.* 2016).

However, in addition to the above, two distinctive barriers unique to ethnic food restaurants were highlighted. One related to the difficulties in procuring authentic ingredients and foodstuffs required for preparation of Chinese meals whilst the other was attributed to the professional ‘conservatism’ of (especially experienced) chefs towards changing their well-established, traditional cooking techniques to avoid wastage (Table 4). These findings are interesting as they pinpoint the important role of the Chinese cultural values of preparing/cooking food in

food waste generation. This suggests the potentially problematic future of food waste management in the context of ethnic food restaurants in the UK. Indeed, food wastage mitigation implies hard, collaborative work of all stakeholders concerned, including suppliers and chefs (Martin-Rios *et al.* 2018). If the latter are not prepared to compromise on their procurement practices and/or cooking methods, then voluntary, industry-driven, food waste mitigation interventions are unlikely to succeed. Closer involvement of the UK government in food waste management in (ethnic food) restaurants may therefore be required. This involvement should continue encouraging foodservice providers to adjust their current business models and practices to make them less wasteful. Most importantly, however, this governmental involvement should also consider adopting more rigid, price-based approaches to (dis)incentivise foodservice operators in food waste mitigation. To this end, monetary incentives can be provided to those restaurants excelling in mitigating food waste whilst financial penalties can be applied to those failing to reduce food wastage within an adequate time period. For example, the 'pay-as-you-throw' approach which has been applied in the context of household food waste management (Dahlen and Lagerkvist 2010) can be adopted and piloted in some UK regions and/or with some willing foodservice operators. The value of greater governmental involvement in food waste mitigation is well explained by the quote below:

> *'I know that in Korea there's clear and strict legislation on food waste. For example, you get fined if you don't separate waste properly. This has made public awareness grow, so ordinary people and restaurant managers now care so much more about food waste. This is completely different from here [UK] as, here, we can do whatever we want with our food waste as long as we pay for disposal'* (Restaurant 7)

4. Concluding remarks

4.1.Conclusions

Food waste in foodservice provision represents a topic of important societal concern which remains, however, under-studied. More research is required to better understanding the magnitude, drivers and approaches to mitigating food waste in different foodservice sub-sectors and national cuisines. To this end, this paper shed light on the phenomenon of food wastage in the context of Chinese restaurants in the UK. By applying a novel assessment approach, it quantified wasted food in a case study restaurant and subsequently validated the figures obtained within a sample of Chinese foodservice operators. The paper identified the main drivers of food wastage and outlined the key managerial approaches to mitigation. It revealed the role of some contextual, local market-related, factors and established the important effect of the Chinese cooking and dining culture in food waste generation and mitigation.

4.2.Limitations

This study is empirical in nature and based on direct observations and measurements of the phenomenon of food waste in ethnic food restaurants. Although the data gathered were compared against theoretical underpinning of food waste occurrence in foodservices, they were nevertheless grounded on real life experiences of researchers and restaurant managers, thus making limited contribution to theory development. The methodological framework for estimating food waste proposed in this study requires validation in other (consumption and geographical)

contexts to enable its theorisation. The findings of this study are restricted to a single category of ethnic food (Chinese) and a single geographical market of its provision and consumption (Bournemouth, the UK). The food waste audit was conducted for one month and in a single restaurant, thus representing a typical case study approach with the known restrictions in terms of generalisability and representativeness of its results. To minimise the negative effect of these restrictions, the results of the monthly food waste audit in a case study restaurant were supplemented with managerial estimates of food wastage produced in the case study restaurant throughout the entire year. These estimates were subsequently validated within a sample of other restaurateurs representing the case studied ethnic cuisine, i.e. Chinese. An annual audit of food waste held in a large(r) number of Chinese restaurants would have generated more accurate results, but was abandoned due to its laborious nature and low cost-effectiveness. The food waste estimate obtained in this study is likely to be an under-estimate due to possible effect of social desirability bias. No differentiation was made between plate waste produced by the case study restaurant's 'regulars' (and, further, between the 'regulars' who are Chinese and non-Chinese) and visitors to Bournemouth whilst food wastage within these categories of restaurant guests is likely to vary given the particular taste and flavour of Chinese cuisine. Likewise, no exact reasons for plate waste occurrence were established whilst these were likely to differ significantly being attributed to such factors as, for example, unusual/unfamiliar taste, portion size as well as size and structure of the dining party, to mention a few.

4.3.Future research

The study outlined a number of promising research opportunities. First, future studies should examine the phenomenon of food waste and its management in restaurants specializing in other ethnic cuisines. For example, Italian, Spanish, Mexican, Thai and Indian restaurants hold

significant shares of the UK's market of out-of-home food consumption and, therefore, represent interesting research objects. Second, a comparative study of foodservice operators specializing in different ethnic cuisines would be interesting to conduct. This is to establish similarities and differences, if any, between the magnitude and drivers of food wastage and approaches to its mitigation across the different national cuisines. This is further to better understand the role of various contextual and cultural factors in food waste and its management. Third, future research should aim at comparing the phenomenon of food waste in ethnic food restaurants in the local market (for example, Mexican restaurants in the UK) and in the country of its origin (i.e. Mexico). This is to explore the (inter)national opportunities and challenges in managing food waste and identify good business practices in its mitigation. Fourth, future research on food wastage in ethnic food restaurants undertaken in popular tourist destinations should aim at comparing the amounts of food waste generated by restaurant 'regulars' and tourists. This is to (more) accurately establish the share of (domestic and international) tourism in the (national and global) challenge of food waste. Fifth, a comparative study of plate waste produced by the expatriates (for example, the Chinese in the case of Chinese restaurants) and local residents (i.e. UK nationals in the case of Chinese restaurants operating in the UK) can provide evidence to the role of national dining habits in food waste generation. Sixth, given this study established the important role of chefs in minimizing restaurant kitchen's food wastage and highlighted their conservatism in adopting less wasteful cooking practices, future research should explore how chefs can be 'nudged' towards pro-active food waste mitigation. This particularly concerns senior and experienced chefs whose knowledge, attitudes and behaviour towards food waste and its management can affect junior and less experienced chefs. Seventh, suppliers should be studied to better understand how provision of authentic cooking ingredients and foodstuffs affects food wastage in ethnic food restaurants, but also within the international food supply chain via, for

example, spoilage in transit. Lastly, a novel approach to estimating food waste in foodservice operations proposed in this study should be trialled for application in other contexts, i.e. within different foodservice sub-sectors and within different geographical markets of out-of-home food consumption. This is to further demonstrate its practical viability and establish factors encouraging its broader adoption by industry professionals and academics.

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Figure 1. Research design

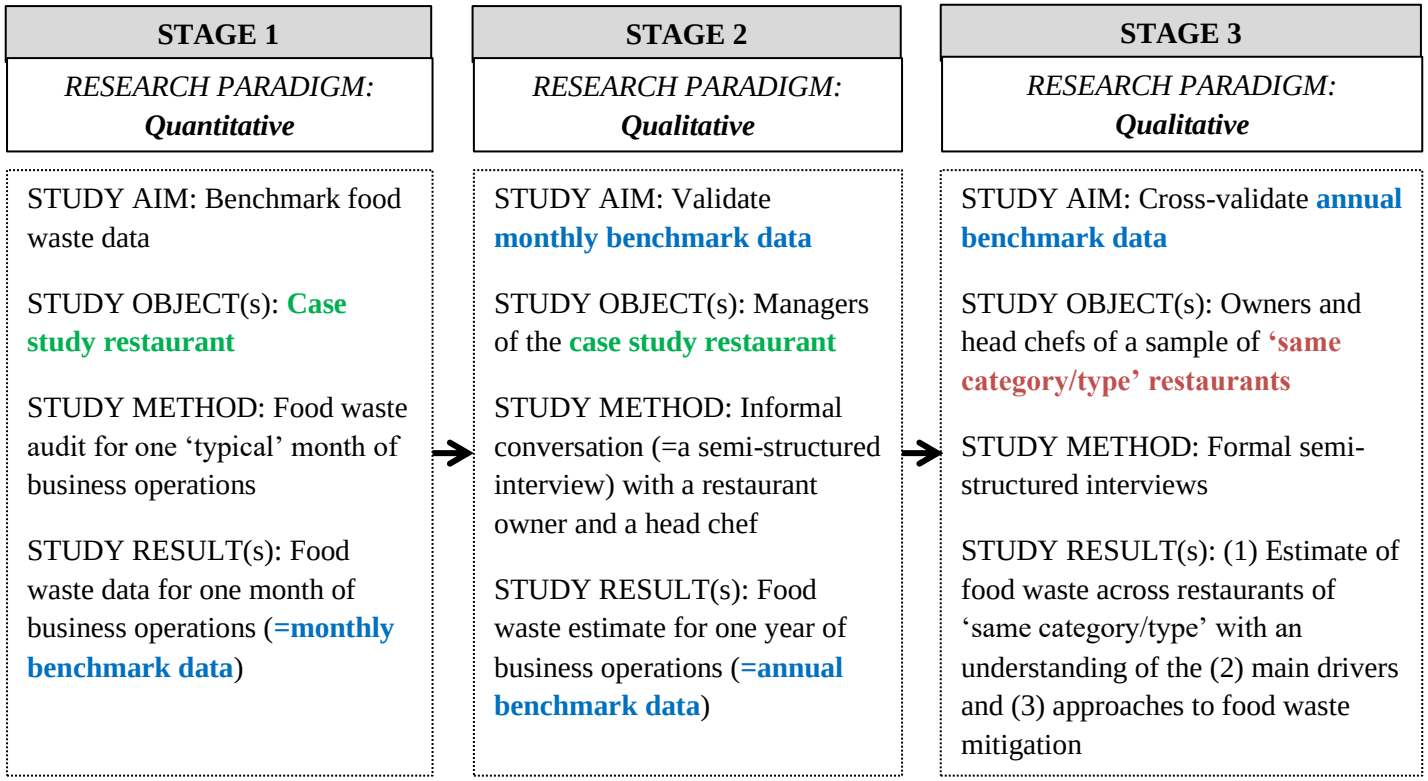


Figure 2. Food waste audit results for one month of foodservice operations. The **red line** indicates the monthly average amount of food wastage.

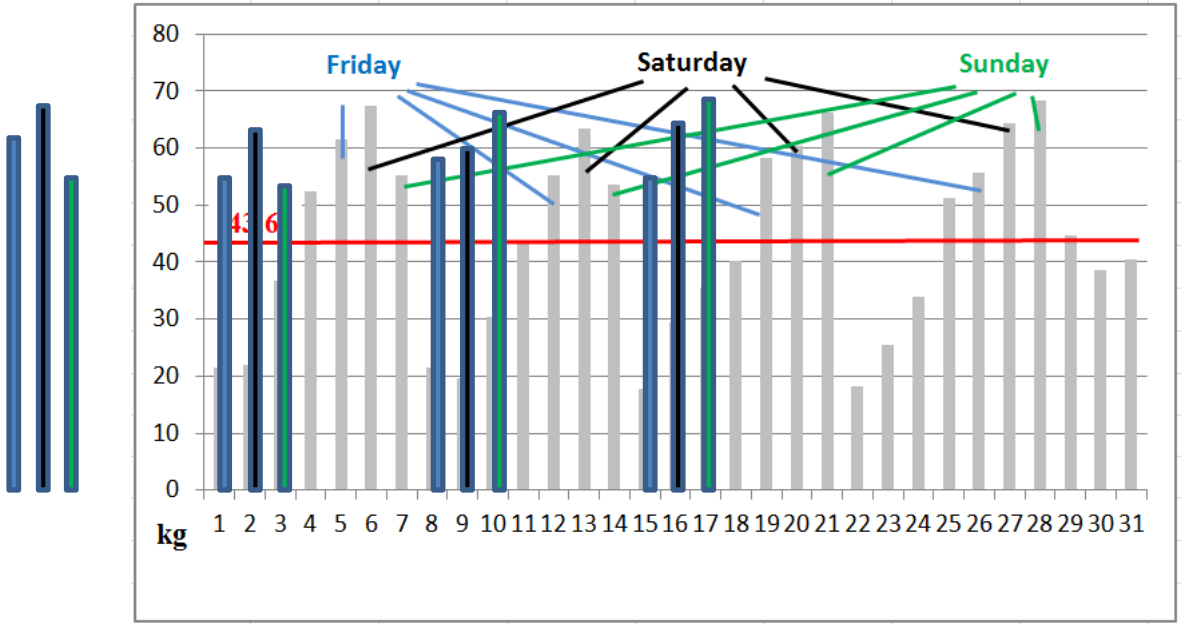


Table 1. Food waste audit results. Marked **in red** the largest amounts of wasted food.

Week	Day	Number of guests	Food waste (kg)	Waste per guest (kg)	Dominant edible fraction (>50%)	Main contributor (>50%)
Week 1 (1-7/7/2019)	Monday	204	21.5	0.105	Rice and noodles	Kitchen
	Tuesday	207	22	0.106	Vegetables	Kitchen
	Wednesday	289	36.7	0.127	Rice and noodles	Kitchen
	Thursday	365	52.5	0.144	Rice and noodles	Customer plates
	Friday	**401**	**61.5**	0.153	Meat and seafood	Customer plates
	Saturday	**407**	**67.5**	0.166	Meat and seafood	Customer plates
	Sunday	**378**	**55.2**	0.146	Vegetables	Customer plates
WEEK SUBTOTAL		**2251**	**316.9**	**0.141**		
Week 2 (8-14/7/2019)	Monday	206	21.4	0.104	Vegetables	Kitchen
	Tuesday	189	19.5	0.103	Rice and noodles	Kitchen
	Wednesday	267	30.5	0.114	Rice and noodles	Kitchen
	Thursday	305	43.6	0.143	Vegetables	Kitchen
	Friday	**378**	**55.2**	0.146	Meat and seafood	Customer plates
	Saturday	**411**	**63.5**	0.155	Vegetables	Customer plates
	Sunday	**367**	**53.5**	0.146	Meat and seafood	Customer plates
WEEK SUBTOTAL		**2123**	**287.2**	**0.135**		
Week 3 (15-21/7/2019)	Monday	178	17.8	0.100	Vegetables	Kitchen
	Tuesday	243	29.5	0.121	Vegetables	Kitchen
	Wednesday	289	35.6	0.123	Vegetables	Kitchen
	Thursday	313	40.3	0.129	Rice and noodles	Kitchen
	Friday	**356**	**58.3**	0.164	Meat and seafood	Customer plates
	Saturday	**388**	**60.4**	0.156	Rice and noodles	Customer plates
	Sunday	**386**	**66.3**	0.172	Meat and seafood	Customer plates
WEEK SUBTOTAL		**2153**	**308.2**	**0.143**		
Week 4 (22-28/7/2019)	Monday	189	18.3	0.097	Rice and noodles	Kitchen
	Tuesday	210	25.5	0.121	Vegetables	Kitchen
	Wednesday	269	34	0.126	Rice and noodles	Customer plates

	Thursday	297	51.2	0.172	Rice and noodles	Customer plates
	Friday	**321**	**55.7**	0.174	Vegetables	Customer plates
	Saturday	**369**	**64.3**	0.174	Vegetables	Customer plates
	Sunday	**376**	**68.3**	0.182	Meat and seafood	Customer plates
WEEK SUBTOTAL		**2031**	**317.3**	**0.156**		
Week 5 (29-31/7/2019)	Monday	334	44.7	0.134	Vegetables	Kitchen
	Tuesday	322	38.5	0.120	Rice and noodles	Kitchen
	Wednesday	329	40.4	0.123	Rice and noodles	Customer plates
MONTH TOTAL		**9543**	**1353.2**	**0.142**		
Daily average		308	43.65	0.142		

Table 2.

(A) Managerial estimates of annual food wastage in the case study restaurant alongside their visual representation. **In green** is the benchmark month of July 2019;

(B) Annual food wastage in the case study restaurant established on the basis of the food audit data and managerial estimates.

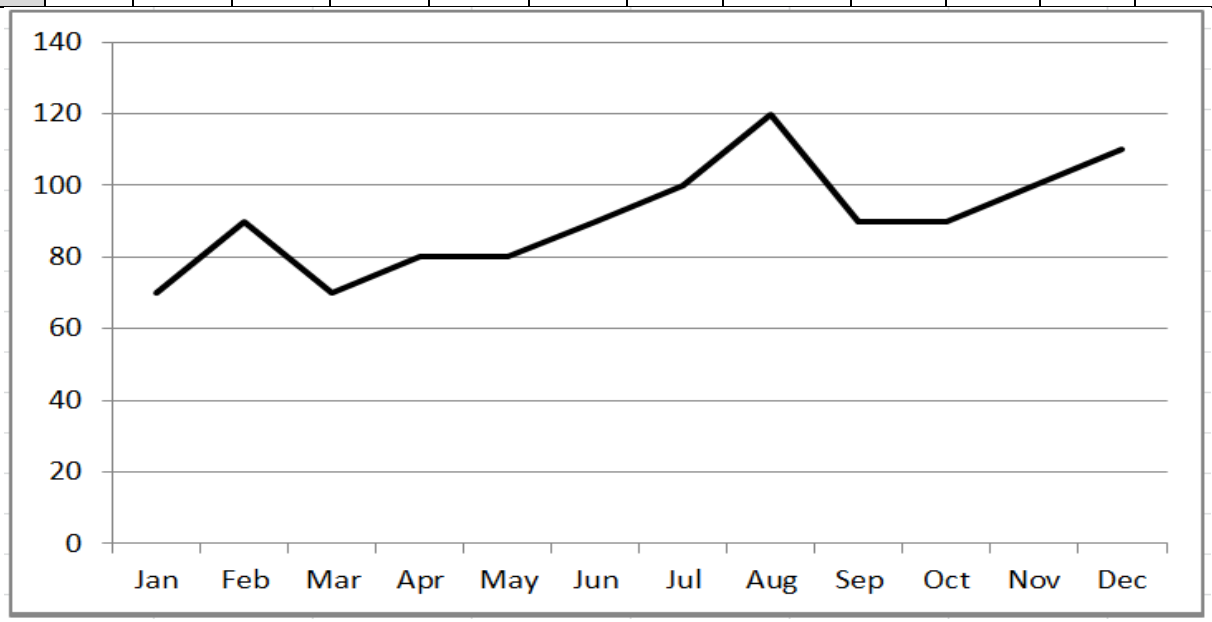
A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	70	90	70	80	80	90	**100**	120	90	90	100	110
												
B	947	1218	947	1082	1082	1218	**1353**	1624	1218	1218	1353	1488
Estimated annual total (kg): 14748												

Table 3. Profiles of Chinese restaurants under study.

ID	**Restaurant capacity (seats)** *Large >75 seats* *Medium 40-75 seats* *Small <40 seats*	**Work experience of the restaurant management team in Chinese restaurants in the UK (years)**
1	100	>30
2	90	>20
3	40	>20
4	35	>30
5	30	>20
6	33	>10
7	50	>30
8	44	>25
9	60	>30
10	50	>20

Table 4. Coding structure with themes and codes. The last column reports on the number (n) and proportion (%) of quotes assigned to each code. Red colour shows the most popular codes.

Theme	Code	Frequency of mentions in interview transcripts
Amounts of food waste generated in comparison to the case study restaurant	Larger	-
	Comparable	6 (60%)
	Smaller	4 (40%)
Most wasted foodstuffs/ingredients	Rice and noodles	8 (80%)
	Vegetables	6 (60%)
	Fresh meat and seafood	5 (50%)
	Sauces	5 (50%)
	Cooking oil	5 (50%)
Drivers of food waste	KITCHEN: Specific nature of the cooking process	7 (70%)
	CUSTOMER: Plate leftovers	7 (70%)
	SUPPLY: Spoilage in transit	5 (50%)
	DEMAND: Unpredictable demand	3 (30%)
	OTHER: Spoilage in storage	2 (20%)
Approaches to managing food waste	Improving accuracy of demand forecasting	10 (100%)
	Smaller, but more frequent food deliveries	10 (100%)
	Portion control	8 (80%)
	Surplus food is given to staff	4 (40%)
	Short menus	3 (30%)
	Proactively offer take-away bags to customers to take plate leftovers home	1 (10%)
Barriers to manage food waste more effectively	Poor consumer awareness of the negative effect of food wastage	10 (100%)
	Lack of governmental support in raising consumer awareness	10 (100%)
	Restricted supply of authentic foodstuffs and ingredients / Power of suppliers	9 (90%)
	Chefs unwilling to change their cooking methods to avoid wastage	8 (80%)
	Food waste is not a business priority	7 (70%)

Table 5. Benchmarking this study's results against food waste figures reported in past studies

Source	Market of out-of-home food consumption	Foodservice type	Food waste figure (g)	Basis of estimates
Eriksson *et al.* (2017)	Sweden	Municipal (contract)	75	Per
Betz *et al.* (2015)	Switzerland	Contract catering	86-91	Per meal
Wang *et al.* (2017)	China	Restaurants	93	Per guest
Wang *et al.* (2018)	China	Aggregate regional	98	Per capita
This study	**UK**	**Chinese cuisine**	**138**	**Per guest**
Silvennoinen et al. (2015)	Finland	Restaurants	153	Per
Tatano *et al.* (2017)	Italy	Restaurants	200	Per meal
Engstrom and Carlsson-	Sweden	Contract and	311-545	Per
SRA (2010)	UK	Aggregate national	500	Per meal
Papargyropoulou *et al.*	Malaysia	Chinese cuisine	600	Per guest