



Research Article

Food Waste from Catering Services in Thai Hotels: A Composition Analysis and Practical Guidelines for Effective Utilization

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Abstract

Food waste from the hotel sector is a significant contributor to the overall volume of food waste, particularly in restaurants and food services through various processes. However, precise data on food waste generated by the hotel industry is lacking. This study aims to quantify and characterize the food waste generated during the preparation and serving processes in hotel catering, with the goal of finding efficient solutions to reduce food waste that are appropriate for the hotel and catering sectors. The study presents novel findings that among the different types of catering, dinner-style buffets (DB) generate the highest amount of food waste, accounting for an average of 96.28% of the total waste. In contrast, gourmet finger food catering (GF) is the most efficient, producing the least amount of food waste. Food waste from hotel catering has potential for biomass production, with the average moisture content ranging from 48.86% to 54.93%. The calorific value of the food waste samples averaged 16.99 ± 4.73 MJ kg⁻¹, indicating its potential as an alternative energy source. Additionally, nutrient analysis revealed nitrogen, phosphorus, and potassium concentrations of 11.37%, 0.41%, and 0.58%, respectively. The C/N ratio was low at 5.62 ± 0.89 , suggesting a high nitrogen content. To optimize composting, carbon-rich materials like leaf litter are required. By implementing these guidelines, hotels can not only minimize their environmental footprint but also enhance operational efficiency, bolster long-term sustainability, and establish themselves as leaders in responsible waste management within the hospitality industry.

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Introduction

Food waste refers to the food that gets thrown away or remains unused throughout different stages of the food supply chain, ranging from production and processing to distribution, sale, and consumption. It's a complex issue that brings together various interconnected challenges such as environmental consequences, depletion of resources, financial losses, and ethical concerns [1]. Tackling food waste requires a comprehensive strategy involving collaboration among stakeholders across the food system, including government entities, businesses, farmers, retailers, and consumers [2]. Several of the Sustainable Development Goals (SDGs) outlined by the United Nations

have strong connections to the issue of food waste. The SDGs provide a roadmap for addressing global challenges and working towards sustainable development by the year 2030. Specific goals, including SDG 2 (Zero hunger), SDG 12 (Responsible consumption and production), SDG 13 (Climate action), and SDG 14 (Life below water) are directly linked to the problem of food waste. These goals emphasize the importance of reducing food waste, promoting responsible consumption and production practices, mitigating climate change impacts, and preserving biodiversity on land and in water bodies [3–4].

In 2023, Thailand generated approximately 26.95 million tons of solid waste, or approximately 73,840 tons

day⁻¹. The waste generation rate compared to the population registered in 2023 by the Department of Provincial Administration is 1.12 kg capita⁻¹ day⁻¹ on average [5]. This is an increase from 2022, with a total waste volume of 25.70 million tons and a waste generation rate of 1.07 kg capita⁻¹ year⁻¹. According to a study conducted by the Pollution Control Department in 2022, food waste is estimated to be the most common type of waste observed at solid waste disposal sites. Food waste was generated at an average of 9.68 million tons, accounting for 38% of total municipal waste. When estimating household food waste production, 39.5% of it remains edible [6]. The UNEP Food Waste Index Report 2024 states that Thailand produces an average of 86 kg capita⁻¹ year⁻¹ [7]. Food waste from the service sector significantly contributes to the overall volume of food waste [8–9]. In 2002, a study examining food waste management in 86 hotels within Hat Yai Municipality found that the average food waste generation rates for large, medium, and small hotels were 0.52, 0.54, and 1.36 liters room⁻¹ day⁻¹, respectively. However, as the data were collected through questionnaires, the findings may deviate from empirical observations and are not reflective of current conditions [10]. This waste is generated in restaurants and food services through various processes, including the reception of raw materials, cutting, cooking, and plating. It also occurs when raw materials are stored for extended periods and spoil before use, when unsold food must be discarded, and from food left uneaten by customers [6, 8]. However, there is a lack of precise nationwide data on the amount of food waste produced by the food service industry. This data gap hinders the development of effective food waste reduction strategies [7].

This research addresses gaps in understanding the composition of food waste in catering, which require further investigation. One significant gap is the lack of exploration into the underlying causes driving the composition of waste across different catering formats, in particular the impact of food presentation and service methods on waste generation. In this context, the Waste Hierarchy Theory [11] serves as the guiding theoretical framework for the study. This theory ranks waste management options based on their environmental impact, prioritizing prevention, reuse, recycling, and recovery over disposal. By studying the composition of catering waste, this research can inform the interpretation of the results of the composition of food waste and waste reduction strategies and promote the recovery of materials in accordance with the waste hierarchy. The discussion on recycling food waste into compost or biofuels further supports this theoretical framework, offering valuable insights that can guide policymakers,

service managers, and environmental planners toward more sustainable practices. For example, the Green Hotel Project, an initiative by the Department of Climate Change and Environment, has been running continuously since 2013. The project aims to enhance the capacity of establishments to use resources and energy efficiently, implement sound environmental management practices, and raise service standards. Additionally, it seeks to expand the network of eco-friendly hotels [12].

In Thailand, hotel catering typically falls into three main formats: buffet banquets, gourmet finger food banquets (also known as cocktail banquets), and Chinese-style banquets [13]. This study's research questions focus on the amount of food waste generated by catering in the hotel industry. It also examines the proportions and composition of food waste from various types of catering during the preparation and serving processes. The goal is to find effective ways to reduce food waste that are suitable for the hotel and catering sectors.

Material and methods

1) Food waste sampling

Food waste samples were collected from hotel catering services in Bangkok and the surrounding metropolitan area, including those with in-house restaurants. A purposive sampling method was used to select the samples, which were categorized into four types: breakfast buffets (BB), dinner-style buffets (DB), gourmet finger food banquets (GF), and Chinese-style banquets (CB). Four samples were taken for each catering style. The samples were collected from food waste bins in the kitchen and any leftover or discarded food from the catering event. The physical characteristics of each sample were analyzed, and the chemical composition was determined using segregated food waste. More details will be presented in the following section.

2) Compositional characterization

2.1) Waste composition analysis

The solid waste from catering services was gathered from four distinct providers and subjected to a physical composition analysis. This analysis involved the systematic segregation of the collected waste according to the following order: food waste, plastic, paper, wood, and other materials (glass, metal, rubber, leather, cloth). The total weight of solid waste collected from both the banquet hall and kitchen/cooking area was measured. The waste was then divided into the aforementioned categories based on their physical characteristics, with the percentage of each component calculated using the ASTM D5231-92 (2008) quartering technique [14]. Additionally, measurements of moisture content, density, and total weight were conducted for each waste category.

The proportions of each type of solid waste were determined by their wet weight.

2.2) Composition analysis of food waste

Food waste was categorized into five major groups based on its fundamental components: 1) the starchy food and grain category, which primarily consists of carbohydrates and includes items like potatoes, bread, rice, pasta, and cereal; 2) meat waste, which is a significant contributor to nitrogen levels in organic waste streams and comprises sources such as fish, poultry, pork, and beef; 3) fruit and vegetable waste, which releases carbon-containing compounds during decomposition; 4) scraps like fish bones, other bones, and skin; and 5) fatty substances such as oil, wax, and grease. The weight of each food waste category was determined proportionally based on wet weight.

The Environmental Center, Suan Dusit University, Bangkok, Thailand, performed chemical analysis on the categorized food waste samples. In brief, these food waste samples were processed through cutting, crushing, and screening, then subjected to examination for characteristics such as moisture content (ASTM D3173), total solids (ASTM D3173), volatile solids (ASTM D3175), ash content (ASTM D3174), heating value (Bomb Calorimeter, LECO A350; EPA 5050), and elemental composition such as carbon (ASTM D3178), hydrogen (ASTM D3178), oxygen (ASTM D3176), nitrogen (Kjeldahl Method, EPA 1687), phosphorus (Spectrophotometer, Shimadzu UV-1800; ASTM D 5198-09), and potassium (Atomic Absorption Spectrophotometer, Shimadzu AA-7000; EPA 3050B). These analyzed chemical properties serve as vital data for making informed decisions regarding future waste management strategies.

2.3) Statistical analysis

The statistical analysis was conducted using GraphPad Prism software Version 5.0 (GraphPad Inc). All data were presented as mean and standard error. The statistical significance was determined using one-way analysis of variance (ANOVA) and Tukey's multiple comparisons test with a p-value of 0.05.

Results and discussions

1) Composition of catering waste

Waste from four types of catering were collected. After weighing the waste samples from various catering events, the researchers proceeded to analyze and categorize the components of the waste into different types, consisting of food waste, paper, plastic, wood, and others (metal, glass, rubber, etc.). The percentage of each waste type segregated according to the types of catering is presented in Figure 1. Among the different types of catering,

DB presented the highest amount of food waste, contributing to an average of 96.28% of the total waste. Conversely, GF emerged as the most efficient, producing the smallest proportion of food waste. Additionally, Figure 2 presents the data on food waste per capita, providing a valuable comparison between the quantity of waste and the number of service users. The food waste production per capita of the BB was the highest among the catering services analyzed. Although no significant difference was observed among all catering services when tested statistically with ANOVA, a paired t-test, however, revealed significant differences in food waste production between BB and GF (p-value ≤ 0.05).

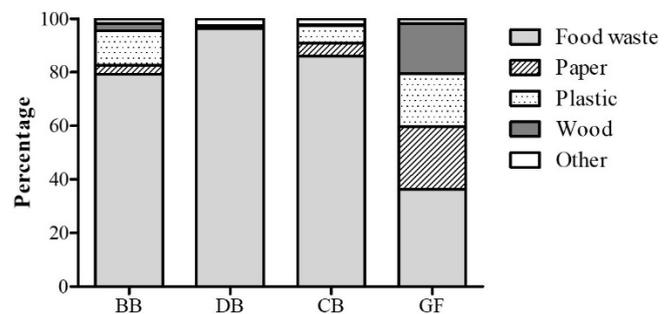


Figure 1 The average composition (expressed in percentages) of the solid waste collected from catering/kitchen bins specific to each catering type (n=4).

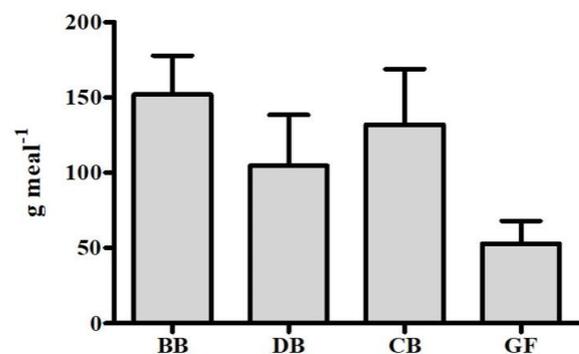


Figure 2 The amount of food waste (measured in g meal⁻¹) from catering/kitchen bins compared across different types of catering services (n=4).

2) Edible food waste composition

Food waste was separated from the total solid waste. The food waste was collected and divided into five different groups: 1) the starchy food and grain category, (including potatoes, bread, rice, pasta, and cereal); 2) meat waste (such as fish, poultry, pork, and beef); 3) fruits and vegetables; 4) food scraps, and 5) fat, oil, and grease. Among the categorized groups, fruits and vegetables are the most frequently abandoned items that contribute to waste. In contrast, meat waste is the least prevalent in terms of discarded quantities, as shown in Figure 3.

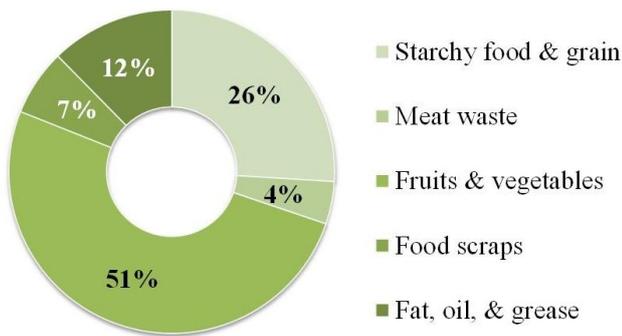


Figure 3 Proportion of each type of food waste from catering.

Narrowing our focus to edible or suitable-for-consumption food waste, we selected three distinct groups for further analysis: (1) starchy food and grain; (2) meat waste; and (3) fruits and vegetables. The production of edible food waste varies among different types of catering services, as illustrated in Figure 4. Most catering services generate the largest amount of food waste from fruits and vegetables. In contrast, CB catering services stand out by producing higher quantities of waste in starchy food and grain compared to other groups. Following an unpaired t-test to compare the production of each form of edible food waste with the catering services category, the findings are also shown in Table 1.

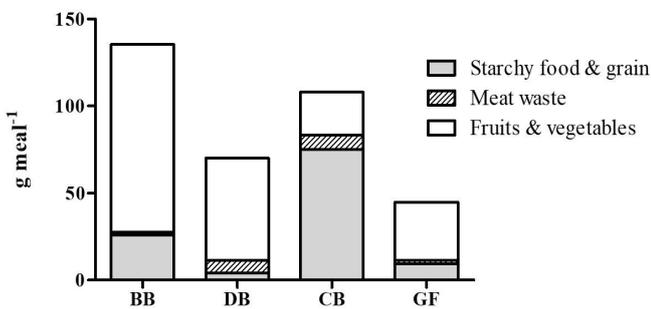


Figure 4 The proportion of edible food waste (expressed in g meal⁻¹) from preparation waste, plate waste, or spoilage compared across different types of catering services (n=4).

The results of the physico-chemical characterization of the food waste samples are detailed in Figure 5 and 6. In Figure 5, moisture content and total solids (expressed

as a percentage) of the edible food waste were compared between each type of the catering service. No significant difference was observed after being tested with ANOVA. The averages for moisture content and total solids across all types of catering services were 70.41±2.96 and 29.59±2.96 (expressed as percentages), respectively.

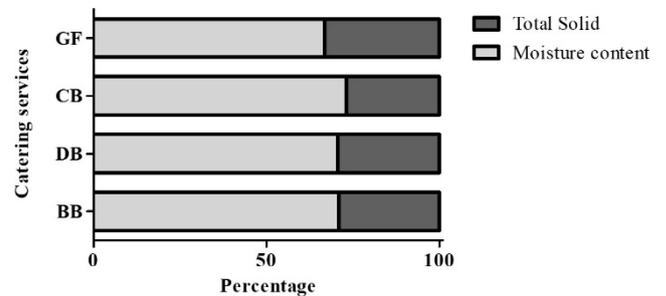


Figure 5 Moisture content and total solids of each type of catering service (n=4).

Examining the moisture content and total solids in food waste samples aids in understanding how the waste can be used. The waste can either be turned into compost or used as biomass fuel for generating electricity. Having the right amount of moisture is really important when turning waste into compost. It's a key factor in making compost production work well. Excessive moisture content can make it difficult for air to pass through the compost pile, which prevents organic materials from decaying through aerobic digestion. Conversely, insufficient moisture in food waste can slow down the decomposition of organic matter into fertilizer. The optimal moisture content range for composting is between 40 and 60% [15–16]. The moisture content analysis of food waste is also crucial for utilization in biomass production as fuel for electricity generation. If the waste contains excessive moisture, it indicates a higher proportion of non-fuel mass in the solid part, leading to a reduction in heating value and a subsequent decrease in combustion efficiency. Therefore, moisture content analysis is both necessary and highly important. Hence, to address the high moisture content, food waste needs to be mixed with other materials or undergo pretreatment to reduce the moisture to less than 50% before incinerating the waste [17].

Table 1 Average weight of edible food waste per capita (g meal⁻¹) (n=4)

Catering services	Starchy food & grain	Meat, poultry, & fish	Fruits & vegetables
BB	25.81±19.10	1.62±1.26	107.83±33.84 c, d
DB	4.22±1.64 a	7.35±3.11	58.48±24.21
CB	75.19±33.84 a	8.06±3.09 b	24.67±2.45 c
GF	9.49±4.95	1.78±0.50 b	33.54±10.92 d

Note: The numbers are shown as average values ± standard error of mean (SE). The identical superscripts (a, b, c, d) indicate a significant difference (p-value ≤ 0.05) between the average values in the column based on the unpaired t test for the examined factors.

In Figure 6, volatile solids, ash and fixed carbon (expressed as a percentage) of the edible food waste were compared between each type of catering service. No significant difference was observed after being tested with ANOVA. The averages for volatile solids, ash, and fixed carbon across all types of catering services were 83.73 ± 2.73 , 4.16 ± 0.63 and 12.11 ± 2.30 (expressed as percentages), respectively.

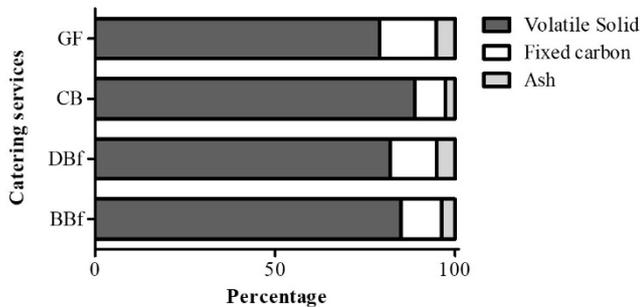


Figure 6 Volatile solid, ash, and fixed carbon of each type of catering service.

The chemical composition of the food waste samples is detailed in Table 2. The ultimate analysis focused on determining the proportions of carbon, hydrogen, nitrogen, and oxygen, which are major components of food waste. The analysis was used to determine the heating value from burning garbage. The oxygen content in food waste has the potential to react with hydrogen, leading to the generation of concealed moisture. This chemical interaction results in the formation of water vapor during the combustion process, contributing to the overall moisture content in the system. This causes the loss of heat energy that occurs when moisture is converted into vapor during combustion. As a consequence, food waste contains a high concentration of hydrogen and carbon but very little oxygen, resulting in an increase in the net heating value. Meanwhile, the inclusion of nitrogen will lower the heating value of the fuel when it undergoes combustion because energy is required to heat the nitrogen that enters the combustion process without contributing to the heat released [18].

Table 2 also displays the levels of three basic plant nutrients (NPK) in sample food waste. The average nitrogen, phosphorus, and potassium content in catering services food waste were 11.37 ± 6.52 , 0.41 ± 0.29 , and 0.58 ± 0.57 , represented as percentages, respectively. The amounts of key plant nutrients (NPK) found in food waste are significant for determining the potential utilization of the waste. Additionally, the carbon-to-nitrogen (C/N) ratio in the waste is important. This ratio plays a crucial role in producing biogas through fermentation. Carbon is decomposed by microbes into small particles, which are then brought into the cell to be used as an energy

source and to produce cell components [19]. Microorganisms degrade nitrogen and incorporate it into their cells to produce biological substances, including proteins and nucleic acids. Normally, the C/N ratio for composting is 30:1 (30 parts carbon to 1 part nitrogen) [16]. The C/N ratio determines the rate of microbial digestion. If the compost pile contains elements with a high C/N ratio (a lot of carbon), decomposition will be slow, and composting will take longer. However, if the compost pile has a low C/N ratio (high nitrogen), nitrogen will be lost to the atmosphere in the form of ammonia, resulting in an unpleasant odor. Figure 7 shows the heating value and C/N ratio of sample food waste. The average C/N ratio across all samples was 5.62 ± 0.89 . To reduce nitrogen loss from the soil during the composting process, a C/N ratio of at least 20:1 is desirable when using food waste for fertilizer. The results of the investigation showed that the C/N ratio of the food waste samples was low. To achieve the optimal C/N ratio for composting it is necessary to increase the carbon content. Carbon-rich materials (such as organic waste and small-cut brown materials like rice straw, wood chips, and maize cobs) can be added to improve the mixture's decomposition efficiency. As mentioned in the previous section, the moisture content in food waste is already high (the moisture value is approximately 70%), making food waste into compost production highly efficient. The average heating value from food waste of all types of catering services was 16.99 ± 4.73 MJ kg⁻¹. Food waste from CB exhibited the highest heating value, while waste from GF displayed the lowest. A paired t-test revealed a statistically significant difference (p -value ≤ 0.05) in the heating value of food waste from gourmet finger food catering compared to that of other catering services. The food waste from hotel catering had a high calorific value compared to other biomass sources. The corresponding calorie values for coconut shells, rice straw, and corn cobs were 25.30 to 30.15 MJ kg⁻¹, 14.08 to 15.09 MJ kg⁻¹, and 16.19 to 16.53 MJ kg⁻¹, respectively [20–22]. Food waste recycling through integrated pyrolysis-gasification processes can result in the production of a variety of high-value products (biofuel, and biochar/ash) with little or no negative environmental impact [23].

The guidelines for using food waste as a biomass fuel are as follows: Firstly, a method needs to be followed to eliminate moisture from food waste. This can be achieved by initially filtering the liquid (broth, oil, or fat) through a sieve, followed by sun drying. Allowing the humidity to decrease will enhance the waste's potential for conversion into biomass fuel.

Table 2 Food waste's chemical composition (percentage by dry weight) (n=4)

Catering service	Carbon (C)	Hydrogen (H)	Oxygen (O)	Nitrogen (N)	Phosphorus (P)	Potassium (K)
BB	47.20±2.68	5.31±0.30	36.99±3.73	7.30±2.49	0.61±0.17	0.79±0.13
DB	45.57±3.40	5.13±0.38	35.42±7.79	13.88±4.34	0.31±0.16	0.27±0.04
CB	49.38±1.72	5.56±0.19	33.62±1.63	11.45±3.53	0.34±0.14	0.90±0.54
GF	43.92±4.36	4.94±0.49	38.29±7.23	12.86±2.74	0.40±0.11	0.36±0.10
Average	46.52±1.52	5.23±0.17	36.08±2.58	11.37±1.63	0.41±0.07	0.58±0.14

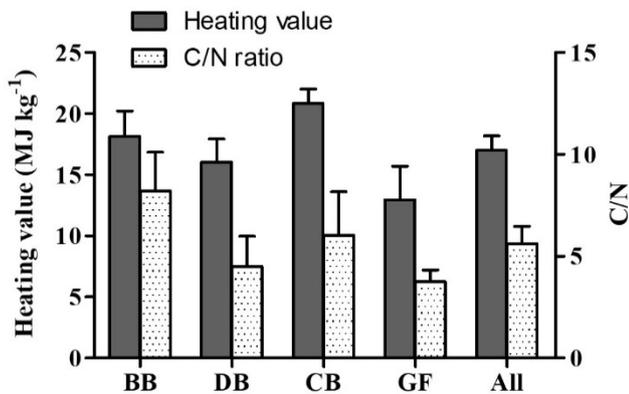


Figure 7 Heating value (MJ kg⁻¹ calculated for dry basis) and C/N ratio of food waste. All represents the average of all types of catering services (n=4).

Discussion

1) Causes of food waste from hotel catering services

Breakfast buffet catering has the highest edible waste per person, followed by Chinese-style buffet catering. Gourmet finger food catering has the lowest amount of edible food waste per person. There are two major reasons why the amount of food waste in each style of catering varies: First, the culinary style provided to clients influences the amount of waste generation. Buffet-style services offer a wide variety of meal options, including salads, vegetables, fruits, and meats on separate trays and cooked items on individual plates. Gourmet finger food catering serves little amounts of appetizers or snacks, such as canapés and salads. A Chinese-style banquet, on the other hand, is a sit-down meal served in multiple courses, beginning with appetizers like fried rice crackers and dim sum to stimulate the appetite, followed by major dishes like pork, shrimp, and fish, as well as starchy foods like noodles or rice. The meal typically ends with a dessert or fruit, reflecting the Chinese belief that food aids digestion and should be enjoyed in stages. Excess food at buffets and gourmet finger food services is frequently reused, donated, or given to employees. In contrast, Chinese banquets use shared platters, which result in more plate trash that comes into contact with diners. Plate waste is not ideal for donation because of sanitary problems, but it can be composted, used as animal feed, or converted into energy. Proper handling of extra food and plate waste is critical for decreasing food waste and increasing reuse potential [9].

The second major reason is that food arrangement and presentation may affect the amount of food waste. Portion sizes significantly affect plate waste, with large portions often leading to more waste [24]. To reduce waste, caterers can serve smaller portions, encouraging guests to finish their food [25–26]. Using full-size plates with reduced surface areas and smaller serving utensils also helps control portion sizes. Buffet setups should maintain an appearance of abundance, avoiding half-empty pans, while integrating cook-to-order stations or food-on-demand services to diversify offerings and further reduce waste. These strategies ensure guests' satisfaction while contributing to waste reduction efforts [27]. Pre-plating perishable or high-cost items, like cheese, and storing them in coolers until ordered helps maintain freshness and minimize waste. This method provides better control over food production and reduces over-production risks. Additionally, cook-to-order stations allow for portion control and efficient management of premium or expensive items [28].

2) Effective ways to reduce food waste from hotel catering services

Hotels and catering services may reduce costs, increase profits, and lessen their environmental effect by cutting down on food loss and waste during the manufacturing and servicing operations. Understanding the reasons for waste in various catering formats is necessary to develop ways for reducing food waste (as previously noted). The variables influencing the different levels of food waste in these catering scenarios will be examined in the sections that follow. The first effective way to reduce food waste from hotel catering services is food donation and redistribution [8, 29]. Hotels can help reduce food waste by collaborating with local food banks or charities to give surplus edible food that fulfills safety standards [8]. However, many Thai hotels, particularly smaller ones, are unwilling to donate because of fears about foodborne illness and associated reputational damage [9]. To promote donations, strong food safety measures are required to preserve recipients' health and the hotels' reputation. Working with organizations like the Scholars of Sustenance Foundation (SOS), which collects and distributes surplus food while keeping the hotel's identity hidden, can help address these concerns. Such collaborations

allow hotels to reduce food waste while meeting their social responsibilities without compromising their reputation [9]. Most countries support efforts to reduce food waste, and donating food to those in need is one such approach. However, in many countries, such as Romania [30] and Cyprus [31], there is no legislation to protect donors from legal liability if food given to a charity in good faith harms the recipient. As a result, food donations are often at the discretion of individual hotels. In contrast, leftover food waste can be used for composting and as fertilizer, a sustainable option widely accepted by many countries and one of the least controversial methods [9, 31-32].

The second way to reduce food waste is related to modifying the food serving process [8]. Gourmet finger food catering services generate less food waste than buffet-style catering due to a variety of variables. Portion control is essential, as smaller servings are simpler for guests to eat, resulting in less leftovers [27, 33–34]. The diversified menu in smaller servings allows diners to sample several delicacies without overindulging in any one dish [35]. Furthermore, events that emphasize socialization, such as cocktail parties, result in lower overall food consumption, further reducing waste [36]. These components help to reduce food waste in gourmet finger food compared to buffet-style catering. The disparity in food waste between Chinese-style banquets and buffet-style services comes from their different serving methods. Buffet-style events allow guests to serve themselves, often taking more food than they can eat, resulting in greater quantities and more waste [28]. Buffet displays are visually appealing, which encourages over-serving [24]. Waitstaff serve pre-portioned food at Chinese banquets, allowing for improved portion control and waste reduction [37]. The serving staff may additionally modify dish proportions based on guest preferences, reducing the possibility of overeating. As a result, Chinese banquets tend to generate less food waste than buffets.

The third method for reducing food waste from hotel catering is to incorporate it into national efforts like the Green Hotel Project [12, 38–39]. To develop a policy, hotels can follow the guidelines below.

- Implement waste segregation practices: Policy integration is essential; Green Hotels should adopt a comprehensive waste segregation policy. Establish separate bins for food waste, paper, plastic, and other recyclables in all kitchen and catering areas. Include monitoring and reporting by regularly analyzing and reporting the composition of waste generated by each catering service. Use these findings to identify trends and areas for improvement.

- Optimize catering services to reduce waste: Promote catering styles that minimize waste, such as the Gourmet

Finger Food approach. For buffets, encourage smaller portions with the option for guests to take additional servings as needed. Include cook-to-order stations, especially for high-value or perishable items, to minimize overproduction and enhance the dining experience.

- Establish a food donation program: Propose measures for becoming a Green Hotel by collaborating with local food banks or organizations like the Scholars of Sustainance Foundation (SOS) for effective food redistribution. This collaboration can provide structured processes for safely donating and transporting excess food.

- Leverage food waste for composting and biomass fuel: Implement composting programs for food waste that meets the optimal moisture content range (40–60%). Use the compost for hotel gardens or donate it to local community gardens.

Limitations of this study

This study is limited by the lack of an in-depth exploration of cultural consumption factors that influence differences in food waste compositions, and constraints on hotel food donation, such as legal liability and reputational concerns. This may affect the volume of food waste. Factors such as hotel size and tourist seasons, including high and low seasons or holidays, are also not considered despite their potential effects on waste generation. Data collection was limited to regular hotel operations, excluding atypical events.

Conclusion

Food waste varies by catering style, with minimal meat waste overall and significant leftovers of starchy foods like rice, bread, and noodles especially from Chinese-style banquets. Vegetables and fruits are widely discarded across all catering types. The study found that food waste from hotel catering has a high moisture content, averaging 70.41%, which is too high for efficient biomass energy production or composting. Ideal moisture levels are 50% for biomass and 45–55% for composting. Methods like sun-drying can reduce the moisture to suitable levels. The waste also had high volatile solids (83.73% of dry weight) and significant fixed carbon content, making it suitable for biomass use. However, the high ash content can reduce its heating value. Moisture content analysis revealed that food waste from hotel catering services contains between 48.86% and 54.93%, making it suitable for biomass use. The average calorific value was 16.99 ± 4.73 MJ kg⁻¹, higher than that of corn cobs and rice straw, and similar to coconut shells.

Furthermore, food waste has significant potential for development into biomass as an alternative energy source. The results of the investigation into the ratios

and concentrations of vital nutrients for plants (NPK) revealed that the food waste sample had values for nitrogen, phosphorus, and potassium of 11.37, 0.41, and 0.58%, respectively. Furthermore, the C/N ratio is determined by dividing the percentage of carbon components by the value of nitrogen. Food waste from all types of hotel catering services was discovered to have a low C/N ratio; it was 5.62 ± 0.89 , meaning it contained a high amount of nitrogen. Therefore, the optimal C/N ratio for turning food waste into compost needs to be proportionate and at least 20:1. To adjust C/N ratios to crop growth, high-carbon materials such as brown matter, wood chips, maize cobs, rice straw, or dry leaf litter (commonly found in hotels) must be added. Food waste already has a high moisture content allowing for high efficiency when used to produce compost. From the above limitation, future research should consider conducting more qualitative studies, such as in-depth interviews with comprehensive stakeholder groups, to gain a deeper understanding of how cultural consumption patterns shape food waste composition. Additionally, investigating the specific challenges hotels face in food donation is crucial for developing more effective and adaptable waste reduction strategies applicable across various food service settings. Furthermore, the amount of food waste should be analyzed in relation to the size of the hotel that provides catering services, the season (high/low season), and the working/holiday schedule. All of these factors influence how much food waste is generated.

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