

Food Waste and its Management in Restaurants in Ibadan North Local Government Area, Oyo State, Nigeria

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Abstract

Food waste in the foodservice sector is currently regarded as an emerging issue of public concern particularly in developing countries like Nigeria. In order to understand the extent of this problem in Ibadan North Local Government Area (LGA), a descriptive cross-sectional study was conducted. A representative sample (70) of restaurant managers were interviewed, using a semi-structured questionnaire, on their knowledge, attitudes, and practices towards food waste management system. Purposive sampling was used to select eight (8) restaurants for compositional analysis of food waste generated for a period of one week. Results showed that 52.9% of the respondents had satisfactory knowledge of proper waste management. Moreover, the respondents showed significantly positive attitude (mean score of 3.66 ± 0.65) towards proper waste management system. However, their practices of food waste management were found to be poor. Mean daily food waste disposal from all the restaurants ranged from 6.0–33.6 kg with yearly disposal that ranged from 2,177.9 to 12,215.7 kg (2.2–12.2 tonnes). The sample average for the study locations was estimated at 5.8 t per year. With average of 30 consumers per day, the per capita disposal was estimated at 24 t/capita/year. Compositional analysis also showed that waste generated were in the order of preparation waste (45%), spoilage waste (21%), and consumer's plate waste (34%). The results showed that poor waste management practices of restaurant managers play significant role in waste generation in restaurant operation. Hence, improved waste management practices such as food waste recycling should be adopted.

Le gaspillage alimentaire et sa gestion dans les restaurants de la zone de gouvernement local du nord d'Ibadan, État d'Oyo, Nigéria

Résumé

Le gaspillage alimentaire dans le secteur de la restauration est actuellement considéré comme un problème qui s'intéresse au public, en particulier dans les pays en voie du développement comme le Nigéria. Afin de comprendre l'ampleur de ce problème dans la zone de gouvernement local (LGA) d'Ibadan Nord, une étude transversale descriptive a été menée. Un échantillon représentatif (70) de gérants de restaurants, a été interrogé, à l'aide d'un questionnaire semi-structuré, sur leurs connaissances, attitudes et pratiques vis-à-vis du système de gestion

des déchets alimentaires. Un échantillonnage raisonné a été utilisé pour sélectionner 8 restaurants pour une analyse de la composition des déchets alimentaires générés pendant une période d'une semaine. Les résultats ont montré que 52,9% des répondants avaient une connaissance satisfaisante de la bonne gestion des déchets. De plus, les répondants ont montré une attitude significativement positive (score moyen de $3,66 \pm 0,65$) envers un système de gestion des déchets approprié. Cependant, leurs pratiques de gestion des déchets alimentaires se sont avérées médiocres. L'élimination quotidienne moyenne des déchets alimentaires de tous les restaurants variait de 6,0 à 33,6 kg avec une élimination annuelle allant de 2 177,9 à 12 215,7 kg (2,2 à 12,2 tonnes). La moyenne de l'échantillon pour les sites d'étude a été estimée à 5,8 t par an. Avec une moyenne de 30 consommateurs par jour, le rejet par habitant a été estimé à 24 t/habitant/an. L'analyse de la composition a également montré que les déchets générés étaient de l'ordre des déchets de préparation (45%), des déchets de détérioration (21%) et des déchets d'assiette des consommateurs (34%). Les résultats montrent que les mauvaises pratiques de gestion des déchets des gérants de restaurant jouent un rôle important dans la génération de déchets dans le fonctionnement du restaurant. Par conséquent, des pratiques améliorées de gestion des déchets telles que le recyclage des déchets alimentaires devraient être adoptées.

Introduction

Food waste is the single largest component of municipal solid waste. It includes uneaten food and food leftovers from residences, commercial establishments, such as restaurants, institutional sources like school cafeterias, and industrial sources like factory lunchrooms (Zhang *et al.*, 2007).

Globally, it has been estimated that about 1.3 billion tonnes of food is either lost and/or wasted every year along the food supply chain (FAO, 2023). In Nigeria, 37.9 million tonnes of food is wasted annually and food wastage per citizen in Nigeria is ranked the highest in Africa (UNEP, 2021). Economic and environmental burdens of food waste are well known. Global economic loss of food waste is put at 1000 billion dollars per year while the environmental implications of food wastage include groundwater pollution, emission of green-house gas and climate change (FAO, 2013; Principato, *et al.*, 2018).

Foodservice sector (restaurants, hotels, coffee shops, cruises, events, contract caterers in work/study canteens and nurseries, as well as street food vendors) (Filimonau *et al.*, 2023) represents an

important outlet for food waste. Its contribution to global total avoidable food waste is estimated to be around 19% or 244 million tonnes per year (UNEP, 2021). It is the second largest generator of food waste after household (Principato, *et al.*, 2018). It is highly important to develop mitigation measures to ensure profitability of the sector and environmental sustainability (Filimonau, *et al.*, 2023). While much research has been carried out on food waste generation at household level, the same cannot be said for the food waste generated by the foodservice sector (Principato, *et al.*, 2018; Papargyropoulou *et al.*, 2016). More specifically, little is known about food waste at restaurant level, as revealed in relevant studies on this topic (Betz *et al.*, 2015; Marthinsen *et al.*, 2012; Pirani and Arafat, 2016; Heikkila *et al.*, 2016). Filimonau *et al.*, (2023) also reported that critical gap exists in research on food waste generation in the foodservice sector particularly in developing countries where little is known about food waste generation in the sector. Given that out-of-home consumption is largely determined by local contexts such as political situation, economic status, and socio-cultural factor. It is important that research

on food waste in the food service sector should be tailored towards local contexts (Filimonau *et al.*, 2023). With increasing trend of eating out in Nigeria, food waste in restaurants is likely to be an emerging issue. However, little is known about the quantity generated, and the causes and mitigation approaches in Ibadan North Local Government Area of Oyo State.

According to West and Resources Action Programme (WRAP, 2013), food waste within the foodservice sector can be categorized into three main waste flows, namely food spoilage, food preparation waste, and consumer plate waste. This can further be categorized as avoidable and unavoidable food wastes. Food waste reduction can be achieved through adopting waste minimization measures during kitchen storage, food preparation, and in food service provision. Unavoidable food waste can then be recycled as nutritious feedstuff for animals such as pig, goat, and cattle or as substrate for anaerobic digestion and composting. These measures will reduce the cost of disposing food waste at dumpsite and the negative environmental impact of disposing them off at dumpsite. However, the success of such endeavour will largely depend on the collaboration between multiple stakeholders in the food service sector (Filimonau, *et al.*, 2023). However, there are few studies that examine the awareness and knowledge of stakeholders in foodservice provision in Nigeria.

Management of food waste is a serious problem in several cities in Nigeria. This is largely due to inadequate knowledge and poor attitude towards

food waste management. In Ibadan North LGA, the restaurant industry likely contributes to national food waste and its downstream effects. However, only few attempts have been made to quantify waste generated in restaurants and also explore knowledge and attitudes towards food waste management. This study sought to understand the management practices in handling food waste in the food service business in Ibadan North Local Area and the measures taken to prevent or reduce food waste. The objective of this study, therefore, is to examine the knowledge, attitude, and management practices of food waste generation in restaurants in Ibadan North LGA of Oyo State, Nigeria.

Materials and Methods

Site Description

The study was conducted in selected restaurants in Ibadan North Local Government, Oyo State, Nigeria. Ibadan North LGA has its headquarters at Agodi in Ibadan. It is a predominantly urban area. It has an area of 420 km² and population of 856,988 inhabitants. It has upscale commercial/residential areas such as Bodija, Agodi, and Sango. It also hosts a number of educational institutions such as the University of Ibadan, the University College Hospital (College of Medicine), and the Polytechnic Ibadan. Ibadan North LGA has eleven (11) political wards as shown in Table 1 (Adegboye, 2014). The number of restaurants population in Ibadan North LGA is one hundred and twenty (120).

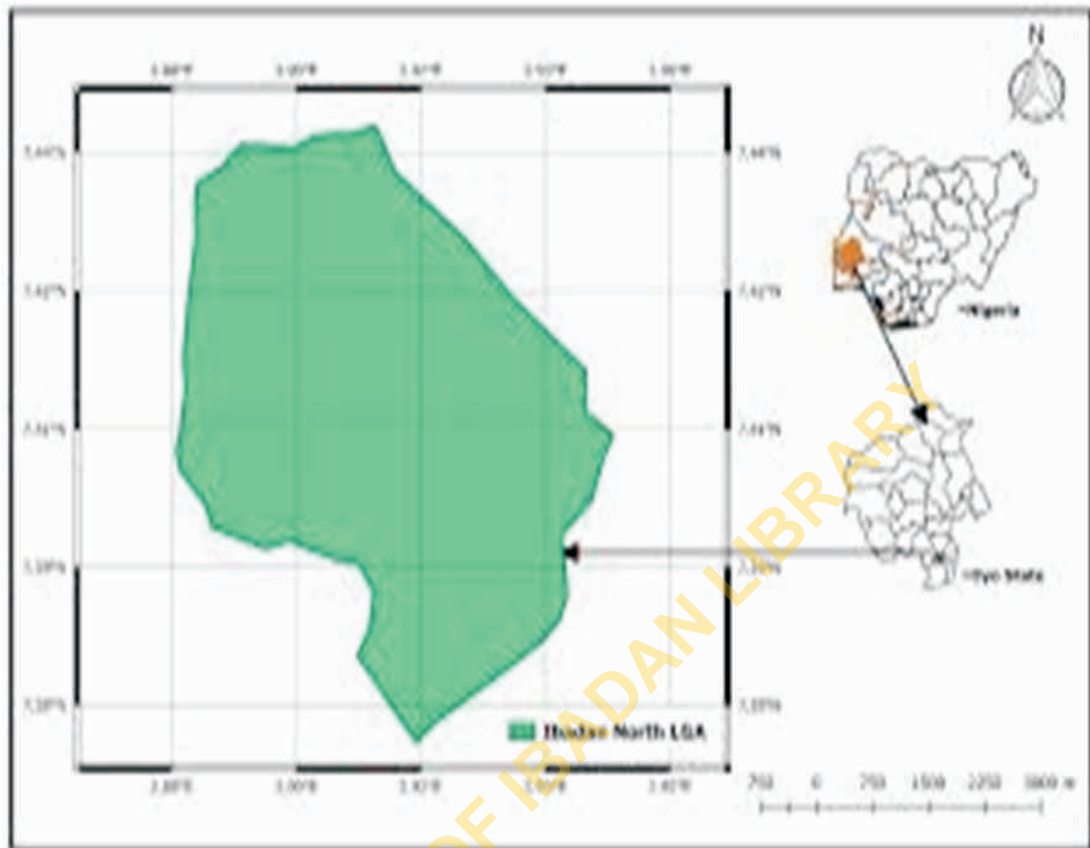


Figure 1: Map of Ibadan North LGA

Table 1: Political wards in Ibadan North LGA

S/N	Ward Area
1.	Beere, Kannike, Agbadagbadu, Oke Are, Ode-Oye
2.	Adeoyo, Inalende, Oniyanrin, Oloro Oke
3.	Adeoyo, Yemetu, Oke Aremo, Isale Alfa
4.	Itutaba, Idiomo, Oje, Igosan, Kube, Abenla, Aluwo, Total Garden, NTA area
5.	Bashorun, Oluwo, Ashi, Akingbola, Ikolaba, Gate
6.	Sabo
7.	Oke Aremo, Coca Cola, Oremeji
8.	Sango, Ijokodo
9.	Mokola, Ago-Tapa, Premier Hotel 10 Bodija, Secretariat, Awolowo, Obasa, Sanusi
10.	Samonda, Polytechnic, University of Ibadan
11.	Agbowo, Bodija Market, Oju Irin, Barika, Isopatako, Lagos-Ibadan expressway

Adeboye (2014)

Study Design

Descriptive cross-sectional design was adopted for this study. Using a simplified equation for sample size calculation for surveys with inclusion of 15% for non-response, a sample size of 225 was obtained. Finite population correction was

applied because the sample size (225) was more than the given number of restaurants population in Ibadan North (120). The final sample size after correction was approximately 70 restaurants. A sample size of 70 was used for questionnaire administration.

Sampling Technique

The study population comprised of restaurant managers in restaurants in Ibadan North LGA. Restaurant managers who did not give consent to participate in the study were excluded.

Multi-stage sampling was employed for questionnaire administration. Ibadan North LGA was purposively selected due to the academic and economy activities within the area in addition to the large number of restaurants in the area. Three (3) wards were then randomly selected from the eleven wards in the LGA. Thereafter, the sample size of 70 was proportionally allocated among three (3) wards namely:

- i. Mokola, Ago Tapa, Premier Hotel
- ii. Samonda, Polytechnic of Ibadan, and University of Ibadan
- iii. Agbowo, Bodija Market, Oju Irin, Barika, Isopatako, Lagos-Ibadan Expressway

Simple random sampling was used to select the number of restaurants needed from the three wards selected based on the eligibility status. All restaurant managers who gave consent in the different locations were interviewed until the required sample size was attained. Also, not all roadside premises could make the sample. However, a spread of the sample size across all the wards selected was ensured.

The study also involved quantification and compositional analysis of food generated in the restaurants. Eight (8) restaurants were purposively selected from the 70 restaurants surveyed and the analysis was carried out for a period of one week.

Data Collection Instrument

The instruments adopted for this study were the direct measurements of waste stream and questionnaire administration and survey on food waste generation in the study area. Questionnaire administration was used to elicit information on knowledge, attitude and practice of food restaurants on proper waste management systems. The questionnaire consisted of four distinct parts which included; demographic characteristics of the participants,

food handlers' knowledge in relation to proper food waste management, food handlers' attitude towards food waste management, and their food waste management practices.

Direct method (Tchobanoglous *et al.*, 1993) was used to collect, sort, weigh, and analyse waste samples collected at the point of generation or just prior to disposal. Using waste compositional analysis, the food wastes were divided into food preparation wastes, consumer plate wastes, and wastes resulting from spoilage. All weights were recorded on-site.

Data Management and Analysis

To ensure quality assurance, the data collected was checked daily for accuracy, consistency and completeness after collection. Data entry was done using SPSS (IBM Corp. Released 2013, IBM SPSS Statistics for Windows, N) for processing and analysis. Descriptive statistics were used to assess participants' characteristics. A weekly average of food waste generated was developed by averaging all daily food waste generation (Monday - Sunday).

Results

Socio-demographics of Respondents and Restaurants Background Information

The socio-demographics of respondents and restaurants background information are presented in Table 2. A total of 70 respondents participated in the study. Majority of the respondents (51.4%) were male. The dominant age of the respondents ranged between 20 and 34 years. Most of the respondents were well educated; 55.7% were holders of diploma and degree certificates. The experiences of the respondents varied. While few of the managers (14.7%) reported to have been in the business for over 10 years, majority (42.6%) had only worked between one and five years. Majority of the restaurants (58.6%) reportedly opens seven (7) days a week (Monday - Sunday) with about 57 (81.4%) reporting the period of more work during the time of the day, as in the afternoon. Majority of the restaurants (71.4%)

were medium to large sized restaurants employing between 11–20 and over 20 persons, respectively.

Knowledge of Food Waste Management

Respondents' views on food waste management are presented in Table 3. Majority of the managers perceived (77.1%) food waste as problem. However,

only few of them (25.7%) had knowledge of the quantity of food waste generated in their restaurants. This is probably reflected in the number of restaurants that have ever tried measuring the food waste they produced. Majority (78.6%) of restaurants have not tried measuring the amount of food waste they produced.

Table 2: Socio-demographics of respondents and restaurants' background information

Variables	Frequency (n = 70)	Percentage (%)
Gender of Respondents		
Male	36	51.4
Female	34	48.6
Educational Level of Respondents		
Secondary	21	30.0
Tertiary	39	55.7
Other	10	14.3
Age of Respondents (Mean \pm SD=31.7\pm4.5)		
20 – 24 years	4	5.7
25 – 29 years	21	30.0
30 – 34 years	27	38.6
\geq 35 years	18	25.7
Number of Days Opened per Week		
5 days	15	21.4
6 days	14	20.0
7 days	41	58.6
Period of More Work		
Afternoon	57	81.4
Night	13	18.6
Number of Workers (Mean \pm SD=15.7\pm7.5)		
5 – 10 persons	24	34.3
11 – 20 persons	28	40.0
More than 20 persons	18	25.7

Table 3: Knowledge of Food Waste Management

Variables	Frequency (n = 70)	Percentage (%)
Perception on Food Waste		
It is a problem	54	77.1
It is not a problem	16	22.9
Knowledge on Amount of Food Waste Generated in the Restaurant		
Yes	18	25.7
No	52	74.3
Ever Tried Measuring Food Waste in Your Restaurant		
Yes	15	21.4
No	55	78.6
Most Common Source of Wastage Within Restaurant		
In the customers' dishes	28	40.0
Kitchen preparation	26	37.1
Leftovers from day's preparation	16	22.9
Pattern of Food Consumption among Customers		
Consume food within restaurants	59	84.3
Take their food away	11	15.7
Heard About Food Waste Management		
Yes	51	72.9
No	19	27.1
Knowledge on Food Waste Management		
Food waste management is a process of throwing waste away	37	52.9
Food waste management is a process of managing waste properly	24	34.2
Don't know	9	12.9
Correct Way to Throw Waste		
Throw by the roadside	10	14.3
Throw into a waste bin	57	81.7
Burn it	3	4.3
Usefulness of Food Waste for Another Purpose		
Yes	43	61.4
No	24	34.3
Don't know	3	4.3
Awareness on Waste Segregation		
Yes	35	50.0
No	24	34.3
Don't know	11	15.7
Knowledge on Waste Recycling		
It is a process of burying waste	3	4.3
It is process of waste into new products	35	50.0
It is a process of dumping waste	25	35.7
Don't know	7	10.0
Improper Waste Collection Leading to Diseases		
Yes	70	100.0
Throwing of Food Waste into Wells, Rivers and Streams Can Cause Diseases		
Yes	70	100.0
Knowledge on Burning of Waste		
It is good	36	51.4
It is not good	30	42.9
Don't know	4	5.7
Awareness on 3Rs (Reduce, Reuse, and Recycle)		
Yes	28	40.0
No	42	60.0

However, majority (84.3%) of the managers observed that their customers consume food within the restaurants which probably is responsible for common source of wastage within the restaurants. This is reflected by the number of managers (40.0%) that reported customers' dishes as the most common source of wastage within the restaurant.

On the knowledge of food waste management, all respondents reported that they have heard about food waste management, with majority (52.9%) of a wrong notion that food waste management is a process of throwing waste away. Majority (81.7%), however, stated that food waste should be thrown in waste bin as against disposing off by the roadside or burning it. While more than half of the respondents agreed that food waste is useful for another purpose, only half of the respondents were aware that waste segregation at the source is necessary to achieve this purpose. It is also interesting to note that half of the respondents viewed waste recycling as turning waste into new products as against burying or dumping it.

All the respondents agreed that improper waste collection and disposal can cause diseases. Similarly, the respondents unanimously agreed that disposal of food waste in wells, rivers, and streams can cause water pollution. On the question on whether it is good to burn waste, more than half of the respondents (51.4%) agreed that it is good to burn waste as against less than half that viewed it as not a good practice. The results also showed that majority of the respondents have not heard about the 3Rs- reduce, reuse, and recycle.

Perception and Attitude towards Food Waste Management

Table 4 shows the responses of respondents to questions on their perceptions and attitude toward food waste management. Fifty (74.3%) out of seventy respondents disagreed that food waste is a useless thing, they do not like it. Majority (74.3%) of the respondents affirmed that they are worried about how waste is generated in their restaurants and equally indicated (81.4%) that poor waste management can affect their health. Their perception was reechoed in their response to how littered wastes affect them. Sixty percent (60.0%) of the respondents disagreed with the notion that even though their surroundings are littered with wastes, they cannot affect them. Moreover, the respondents showed significantly positive attitude (mean score of 3.66 ± 0.65) towards proper waste management system.

Forty-four (62.8%) out of the seventy (70) managers interviewed agreed that they are also responsible for generation of waste in their restaurants. Majority of the respondents (58.6%) disagreed with the notion that burning of waste is the easiest way of disposing food waste. Perception about composting as a strategy to manage food waste was low. Only 17% of the respondents agreed that composting is a good way of managing food waste while majority (45.7%) were undecided. However, respondents' perception about waste segregation was positive, as majority (57.1%) agreed that segregation at source is necessary before recycling.

Table 4: Perception and attitude towards food waste management

Questions	Agree	Disagree	Undecided
I am worried about how waste is generated in my restaurant.	52 (74.3%)	10 (14.3%)	8 (11.4%)
Poor waste management can affect my health.	57 (81.4%)	13 (18.6%)	-
Burning of waste is the easiest way of disposing it.	25 (35.7%)	41 (58.6%)	4 (5.7%)
I am also responsible for the generation of waste in my restaurant.	44 (62.8%)	13 (18.6%)	13 (18.6%)
I feel composting is a good way of managing food waste.	17 (24.3%)	21 (30.0%)	32 (45.7%)
I can make money if my waste is separated properly into paper, nylon, food waste, and plastic waste.	35 (50.0%)	10 (14.3%)	25 (35.7%)
Segregation (separation of waste into paper, nylon, plastic) at source is necessary before recycling.	40 (57.1%)	19 (27.1%)	11 (15.7%)
Even though my surroundings are littered with waste, it cannot affect me.	24 (34.3%)	42 (60.0%)	4 (5.7%)
It is good to throw waste on the ground near the litter bin when the bin is full.	10 (14.3%)	60 (85.7%)	-
Food waste is a useless thing, I don't like it at all	18 (25.7%)	52 (74.3%)	-

Half (50%) of the respondents agreed that they can make money if their wastes are separated properly into paper, nylon, food waste and plastic waste.

Food Waste Management Practices

Respondents' answers on food waste management practices are presented in Table 5. There was disparity in their responses to questions on waste separation. While majority of the respondents (67.1%) reported that they separate their waste into paper, plastic, nylon and food waste, majority (47.0%) indicated that they do not regularly sort out food waste for disposal separately from general waste. Moreover, only 4 out of the 70 respondents reported that they deposited their food wastes in the open field while majority (46 respondents) reported that they used black nylon, plastic drum, metal drum, or sack to deposit their food wastes. To determine how accessible are they to the services of waste collectors, majority (90.0%) indicated that waste collectors come to carry waste from their restaurants while the frequency of collection reported varied from once a week (46.0%), to every-2-days and everyday (15.9%). Only few respondents (4) used private waste collectors as a method disposing food waste in their restaurants, while majority (58) used either government waste collectors or burnt their food wastes. Compost was not generally practiced as a

means of resource recovery in the studied restaurants as 60 out of the 70 respondents indicated that they do not compost food waste in their restaurants.

Food Waste Generation across the Selected Restaurants

Eight (8) restaurants, designated as restaurants A, B, C, D, E, F, G and H, were selected for compositional analysis of the food waste for a period of one week. The results are presented in Figures 2 and 3. The selected restaurants opened from Monday to Sunday. The daily food generation was not less than 4 kg in all the restaurants (Figure 2). The highest generation from all the restaurants was 50.3 kg (Figure 2). There was not a particular pattern of food generation observed in all the restaurants. The means of daily food waste generation ranged from 6.0 to 33.5 kg.

The compositional analysis of food wastes by types is represented in Figure 4. From the results, food preparation accounted for highest waste generation from all the selected restaurants. Food preparation waste could be either avoidable or potentially avoidable wastes. Interestingly, waste from consumer plates accounted for 21% of total wastes generated from the selected restaurants while spoilage accounted for the least.

Table 5: Food waste management practices

Variables	Frequency (n = 70)	Percentage (%)
Separation of Wastes in to Paper, Plastic, Nylon, and Food Waste		
Yes	47	67.1
No	19	27.1
Don't know	4	5.7
Point of Food Waste Deposit at Restaurant		
Black nylon	44	62.9
Plastic drum	13	18.6
Metal drum	3	4.2
Sack	6	8.6
Open field	4	5.7
Use of Waste Collector Service		
Yes	63	90.0
No/Not sure	7	10.0
Frequency of Waste Collector Visits (n = 63)		
Everyday	10	15.9
Every-2-days	24	38.1
Once a week	29	46.0
Sorting of Food Waste for Disposal Separately from General Waste		
Yes	19	27.1
No	47	67.1
Not sure	4	5.8
Method of Food Waste Disposal in Restaurant		
Burning of waste	21	30.0
Government waste collectors	37	52.9
Private waste collectors	8	11.4
Not sure	4	5.7
Do you compost food waste in restaurants?		
Yes	10	14.3
No/Not sure	60	85.7



Figure 2: Daily Food Waste Generation from selected Restaurants

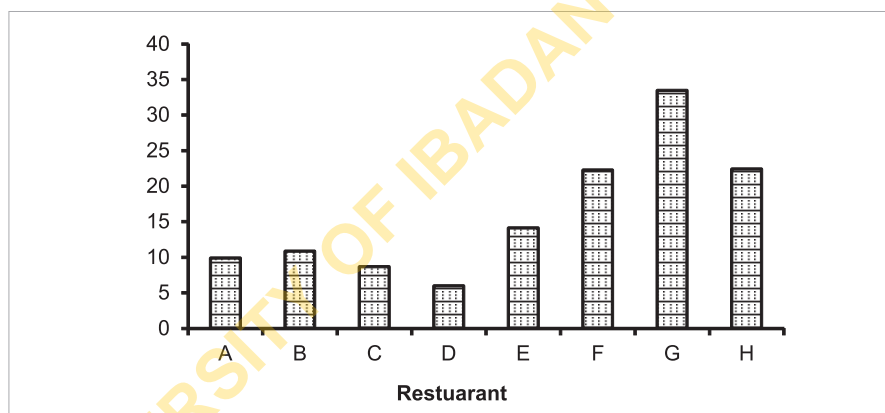


Figure 3: Mean of Daily Food Waste generation

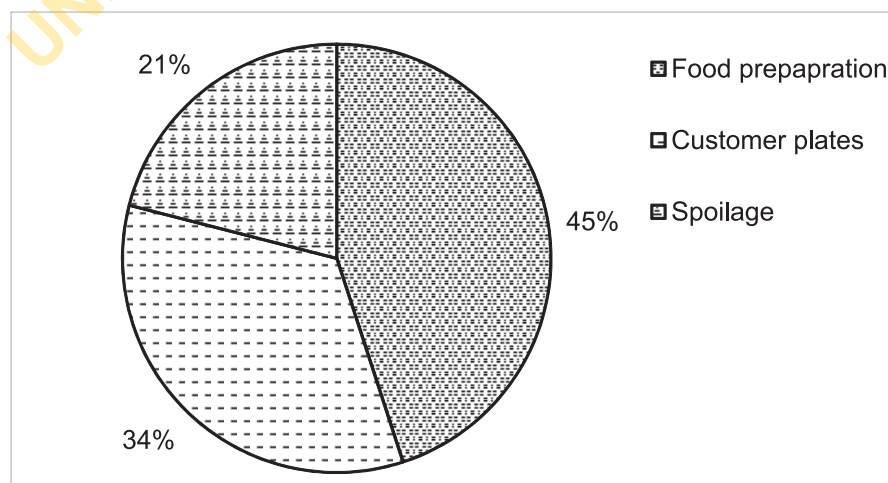


Figure 4: Compositional analysis of food wastes by types

Discussion

This present study examined the knowledge, attitude, and perception of restaurant managers as regards food waste management in Ibadan North LGA. Restaurants represent an important outlet for food waste generation. Success of any food mitigation measure in restaurants will largely depend on collaboration between stakeholders in restaurants' operation, as they can affect and can be affected by food waste generation (Filimonau *et al.*, 2023; Bhattacharya and Fayezi, 2021). In this respect, knowledge, attitude, and perception of restaurants' managers are vital to achieving an effective food waste management in restaurants. The results of this study showed that restaurant managers in the study locations are aware of environmental hazard of food wastes. This was reflected in their responses to enquiry on their perception about food waste as a problem. Perception is related to their level of awareness. Perception is used in behaviour to determine what an individual thinks about certain things or issues; this can only be possible through access to right information. It is, therefore, safe to equate high perception to high awareness. High awareness was also reflected in their responses to some questions on their knowledge about food waste. Higher proportion of the respondents agreed that food waste is a resource. Also, source separation from waste stream from the restaurants is required to implement resource recovery as a mitigation measure for food waste in restaurants' operation. The high level of awareness can be related to the educational attainment of the respondents. Higher level of education normally translates to higher level of understanding and acceptance of new ideas, as well as higher awareness of issues (Lang, *et al.*, 2020). More than 80% of respondents in this study had either secondary or tertiary education, which was also reflected in their level of awareness about environmental hazard of food wastes. The observed result is in line with the findings of Lang *et al.* (2020), who examined awareness of food waste recycling among restaurant managers in China. The study

found that high level of education of restaurant managers was an important factor in high awareness of the environmental hazards of food waste. Similarly, Wu *et al.*, (2019) observed that the level of education was an important factor that affected their environmental awareness and behaviour. Age of respondents also played a role in their level of awareness. The age of majority of the respondents was found to lie between 20 and 34 years. It is believed that when restaurant managers are older, their ideas become more conservative, and their receptivity to new ideas tends to be very low (Lang *et al.*, 2020).

Despite the high level of awareness of problem of food waste among the respondents, only few respondents (15.0) had ever tried to measure food waste in their restaurants. This might be because of their poor understanding of the potentials of food waste generated in their restaurants. Food waste holds a lot of potentials for resource recovery processes such as anaerobic digestion and composting.

The results of this study show that the respondents had satisfactory knowledge of proper waste management. Majority of the respondents were aware of food waste management, indicating that they were aware of waste segregation and believed that waste recycling was a process of converting waste into new products. For restaurant managers, knowledge of food waste management and treatment methods is vital for reducing waste of resources and economic benefits (Bharucha, 2018). Filimonau and Delysia (2019) equally reported that treatment method was related to the knowledge of food waste generated in the restaurants. These findings reflect the importance of knowledge in food waste management. As previously mentioned, the observed level of knowledge can be attributed to the educational attainment of respondents. The observation is in line with the study by Mamady (2016), who indicated that respondents with no education, whether primary education or secondary education, were less likely to know the implication of improper waste management.

Overall, respondents showed a significantly positive attitude towards proper waste

management systems as reflected in their responses to questions on attitude towards proper waste management. For instance, most of the respondents agreed that "food waste is a serious problem" and "poor waste management can affect their health". This is an interesting finding as restaurants managers' attitude plays a significant role in proper waste management. Principato *et al.*, (2018) also found a significant relationship between restaurants managers' attitude and behaviour, and food waste reduction. This thus implies that positive attitude towards proper waste management can impact the amount of food waste generated.

Regarding the food waste management practices, this study found that respondents did not have good food waste management practice. A disparity was found between respondents' responses to questions on waste separation. Majority reported that they separated wastes into paper, plastic, nylon, and food waste. However, majority also indicated that they did sort food waste for disposal separately from general waste. The reason for the disparity is not clear. It is possible that the respondents did not fully understand the questions. Majority of the restaurants' managers reported that they used black nylon for food waste collection and either evacuated the food wastes through the services of government or private waste collectors or burnt them. Black nylon traps heat and could aid decomposition of food waste. Decomposition of food waste in black nylon may have some detrimental implications on the environment. Similarly, burning food waste is not an environmentally-friendly practice of food waste disposal. Composting, which is the process for resource recovery from food waste was not generally practiced in the surveyed restaurants.

Although, no particular pattern was found for results of food waste measurement, the study found that quantity of food waste generated varied significantly depending on the restaurant and the day of foodservice provision. Weekdays were characterized by the largest food waste than weekends for most of the restaurants. This finding is not consistent with the finding of a recent study in Iraq by Filimonau *et al.*, (2023), that indicated that Thursday, last working day and

Friday is the first weekend day in Iraq were associated with excessive food waste generation in the commercial foodservice sector. The high generation of food waste during the week days could be attributed to the lifestyle in the study locations. Most residents in the study locations work from Monday through Friday and are likely to eat out during the week days, especially during lunch break, then on weekends when they mostly stay at home. This observation is also supported by the result of the period of more work. The respondents' reported the period of more work during the time of the day as in the afternoon.

Food waste generation can be expressed as the total weight of food waste per year (tonne/year) and per capital (kg/day or kg/year). On the average, the daily food waste production from the restaurants ranged from 6.0 kg to 33.6 kg, which translates to 2,177.9 to 12,215.7 kg (2.2 – 12.2 tonnes) food waste generation per year. The sample average for the study locations was estimated to be 5.8 t per year. This average food waste figure is considerably lower than the values recorded for restaurants in Iraq (25 t per year) (Filimonau *et al.*, 2023) and Russia, (14 t per year) (Filimonau and Ermolaev, 2021). With 120 registered restaurants in Ibadan North LGA, the estimate of food waste generation from restaurants in the LGA can be obtained by multiplying the average food waste value recorded (5.8 t per year) with 120. This gives an estimate of 696 t per year.

In this study, there was an average of 30 consumers a day per restaurant. This implies that the food waste per capital for the study locations ranged from 0.2 – 1.1 kg/day and 72.6 – 407.2 kg/year. Similarly, the sample average of food waste per capital for the study locations was estimated to be 194.1 kg/capital/year (0.2 t/capital/year). This value translates to estimate of 24 t/capital/year of food waste from the restaurants in the LGA.

The results of on-site waste audits indicate that dominant sources of food waste in restaurants in the LGA are food preparation and customer plates. This finding is in line with that of Hennen (2019) who reported the dominance of kitchen food waste in restaurant operations, while

it is at variance with that of Filimonau *et al.*, (2023), who reported that most food waste in restaurants occurred on customer plates. This finding thus suggests that both restaurant managers and customers are to be blamed for food waste generation in the study locations. As acknowledged in the literature (Filimonau *et al.*, 2023), the business-related causes of food waste can be attributed to long menu, which increases possibility of over-stocking and consequent food waste occurrence due to spoilage. Also included are cooking errors, as a result of lack of skills among kitchen staff, the busy nature of operations, and lack of infrastructure for proper storage.

Contributions from business-related sources can be attributed to poor waste management practices. Poor practices of restaurant managers as earlier mentioned, could imply that the wasted food are disposed of rather than recycled, which probably explains significant contributions of business-related causes. Contribution of customer plates to food waste occurrence might be related with customers' behaviour. Most of the respondents reported that customers' ate or consumed their food within the restaurant, which probably explains the contribution of consumer plate to food waste generation. Customers' behaviour may be related to age. Older customers were reported to waste less food than younger customers due to their understanding of the cost implication of procurement of food materials and food preparation (Filimonau *et al.*, 2023). Young customers are also likely to want to show off their hospitality especially when they dine in group; thereby ordering for more than what they can consume while the surplus end up in waste bin. As equally pointed out by Filimonau *et al.*, (2020) and Filimonau *et al.*, (2023), other category of wasteful customers such as group of business people and government officials could have been responsible for the observed contribution of customers' plate. It has been reported that this group waste food due to etiquette and social rules (Filimonau *et al.*, 2020).

Conclusion

This study contributed to the understanding of knowledge, attitude, and perception of restaurant managers toward food waste management in restaurant operation in Ibadan North LGA. The study found that restaurant managers had high awareness, satisfactory knowledge, and positive attitude, but poor practices of food waste management. In addition, average value of yearly generation of food waste in the study locations was found to be considerably lower than other countries. Food preparation and customer plate were found to be dominant sources of food waste in restaurant operation in the study locations.

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