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A Life Cycle Assessment of Hospital Food Waste: A Model For Large Scale Commercial Impact Reduction

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ABSTRACT Current commercial landfill diversion techniques typically focus on recycling, but this method can be environmentally costly when compared scenarios involving the implementation of composting or waste reduction within large facilites. A life cycle assessment (LCA) can be used to provide better information on the environmental impact of different landfill diversion strategies. In this LCA, the impacts of individiual products were quantified in terms of global warming potential, which provides comparable impact categories for analysis. This study gathered information from previous literature about plant-based and omnivorous diets to simulate what the possible impact would be for a city, like Chicago, to implement a large-scale composting initative within facilites such as hospitals. The results of this study suggests that composting had a high environmental pay off as a waste diversion technique, especially when coupled with a plant structured diet and waste reduction.

INTRODUCTION

Within the United States, 22 percent of the national anthropogenic methane emissions occur due to waste disposal into landfills- the primary method of disposal nationwide (Staley and Kanter, 2018). Municipal Solid Waste (MSW) is defined as a person or entity's used products, which are then broken down into categories based on which process of disposal the waste undergoes: recycling, composting, going to landfill, or undergoing combustible energy recovery (Staley and Kanter, 2018). The average American produces 4.9 pounds of municipal solid waste per a day with around 21 percent of that mass being recycled, 6 percent composted, 9 percent undergoing energy recovery via combustion, and 64 percent sent to landfill (EPA, 2021; Staley and Kanter, 2018). The latter numbers do not indicate how incentivizing alternatives to landfilling, such as composting, or how encouraging waste reduction prior to use, can support the lessening of emissions omitted from MSW. A major concern with current MSW disposal is the over 50 percent landfill rate since landfill gas, or LFG, is roughly composed of a

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small number of organic compounds, and greenhouse gases: 50 percent methane, and 50 percent carbon dioxide (EPA, 2018). The Intergovernmental Panel on Climate Change (IPCC) AR5 (IPCC, 2014) assessment report details that methane is 28 to 36 times more potent of a greenhouse gas than carbon dioxide. Furthermore, when reviewing literature pertaining to the severity of landfilling waste, the Environmental Protection Agency (EPA, 2020) cites landfills as one of the greatest causes of anthropogenic emissions, being only second to enteric fermentation. From these figures, it appears that large volumes of solid waste diversion into recycling and composting could play an important role in preventing methane gas production via decomposition (EPA, 2016).

Composting and recycling are two of the common disposal methods in which municipal solid waste is diverted from landfills. While recycling provides communal benefits, there are environmental and monetary costs that skew the net benefits by the end of a products' life cycle (Staley and Kanter, 2018). Because of inefficiencies within the recycling process, recyables are often landfilled anyway, or the emission output of transportation and processing nearly outweighs the benefits (Greenpeace, 2020). It appears that composting and waste reduction at the source are two environmentally beneficial waste management options viable for large facilities that have consistently high volumes of waste production (Staley and Kanter, 2018). Within urban areas, some examples of large facilities that have volumes of waste worth diverting towards composting initiatives include colleges, restaurants, prisons, and hospitals. In this study, we focus specifically on hospitals. Using data on food preparation within hospitals, an analysis of data through a life cycle assessment (LCA) allows for a comparison of the potential environmental costs and benefits if a composting and/or waste reduction model were to be implemented. Surveys of hospital food waste present ranges of food waste per a plate with a range of 6 percent to 65 percent of food mass, with the most typical range being 15 percent to 35 percent, or an average of 31 percent of food wasted per a plate (Alshqaqeeq, Twomey, & Overcash, 2018). These figures giving a general view of plate waste generation in medical facilities, and indicate the opportunity provided for reducing impact. To quanitfy this potential environmental benefit, I completed an analysis of possible food waste diversion strategies, particularly food waste composting and waste reduction, of prepared patient meals. In this analysis, waste reduction is defined as the facility's ability to provide on demand meals, food choices, and smaller meals in order to diminish the amount of potential waste. This analysis focuses specifically on food based on the assumption that not all facilities have compostable dining wear and paper products are mostly recycled.

Life cycle assessment is a quantitative technique used to convert inputs into impact categories (i.e. global warming potential) that can be summed and compared. In this study, I quantified the global warming potential (GWP) of the impacts of the agricultural production of the food, transportation required from the hospital to the composting site, and the food wasted per plate. GWP was expressed in equivalent units, or kilograms of carbon dioxide equivalents (Vallero, 2019). These equivalent units act as a basis of comparison for greenhouse gases. This study defines the functional unit as the GWP impact of food waste per a gram of waste produced within a hospital, as well as the impact of a typical individuals' daily meals. The system being analyzed involves the farming of the ingredients, the transportation of the food to the facility, and then the transportation to the composting facility.

This study will investigate the impact of composting while considering how plant-based verses omnivorous diets may have an effect on these figures. The impact figures are then considered after using a reduction method to simulate the typical volume of waste left on hospital trays. This study is primarily concerned with understanding how industrial composting compares to current large-scale recycling systems.

METHODS

Collection of Data

Life cycle assessments are useful in analyzing "cradle-to-grave or cradle-to-cradle impacts associated with multiple stages of a product's life" (Muralikrishmas & Manickam, 2017). This process allows for quantification of a product's impact by evaluating each stage via comparable impact categories, like the global warming potential (Vallero, 2019). Once the studied stages of a product's life cycle have been converted into comparable units of global warming potential (measured in carbon dioxide equivalents), the impact of the entire cycle can be summed and compared to understand the complete impact of the product, with individual stage impact being reported as well (Muralikrishmas & Manickam, 2017). For example, the GWP of 1 kg methane is 25 kg CO_2 equivalents since is it 25 times more potent in relation to increasing the severity of the climate warming than carbon dioxide (EPA, 2020). It is important to note that GWPs use carbon dioxide as the reference gas with a GWP of 1, so 1 kilogram of methane creates the same warming effect as 25 kilograms of CO_2 (EPA, 2020).

Functional Unit

Defining a functional unit allows for quantification of the expected performance of the system, or parts of a system, being observed (Consequential LCA, 2017). For this study, there are three functional units within the defined system. The system being analyzed involves the food waste once it is disposed of by the patient and then the transportation of waste to the composting facility. The first functional unit is the impact of grams of food waste per a day's worth of meals as well as the impact for a day's meals (including 1,500 kilocalories). These calories can come from a variety of meals, so I focus specifically on two diets: plant-based meals versus meals including meat, or omnivorous. A waste reduction scenario is also analyzed: the impact of both types of diets after each food mass is reduced by 30 percent.

Global Warming Potential (GWP)

This study consists of a collection of data from multiple reviews that assessed various environmental impacts of food item components based off of the emissions required to produce the item in terms of global warming potential. With GWP allowing for equivalent unit comparison among various greenhouse gas impact, the EPA (2021) notes that varying products can be analyzed through this calculation for a more wholistic view on impact. *Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficient, and food choice* (2017) is the source for the figures used to determine the GWP. This paper takes data from multiple sources on GWPs for specific products. For example, the average GWP for yogurt is 1.41 kg CO_2 equiv, which can be found in its' respective table columns (Tables 2 and 3).

Food Selection

In order to create a basis of comparison to a legitimate medical kitchen setting, I used an online menu obtained from the University of Wisconsin (n.d.) and chose three semi-prepared meals that included an entrée, two sides, a dessert or side, and a beverage for a plant-based diet versus one that incorporates meat. A plant-based diet is defined as one in which a high proportion of vegetables, fruits, and whole grains are present with some animal products included (i.e. diary) (McManus, 2018). Using the United States Department of Agriculture's "Food Data Central" database, meals were pieced together based on general nutrition guidelines and a total calorie intake around 1,500 kilocalories. After picking the respective meals and organizing caloric and mass per serving information in an Excel sheet, GWP per a serving was calculated using the average of the converted per gram figures compiled from the supplementary figures provided in *Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficient, and food choice* (2017), and percentage figures (30 percent) analyzed in *Food waste in hospitals: Review* (2018). These figures have already converted the mass per a gram of the food product to the equivalent factor, which was then used to determine the overall GWP for the desired mass.

Transportation

For transportation of food waste to composting facilites, we used the average distance between the main compost transport station at 200 Rockwell and the hospitals within Chicago (about 16.38 kilometers). The EPA (2021) states that the GWP of one gallon of diesel fuel is 10,180 grams of CO_2 equivalents, which allows for the calculations and conversions required to estimate the GWP per round trip- a trip not including the distance between hospital pickups. With gas mileage significantly decreased in the city, reviewing associated emission rates per a kilometer of the various transportation options is fundamental in completing a more holistic assessment. The miles per a gallon value used was 6.07, or about 2.58 kilometers per a liter (North American Council for Freight Efficiency, 2018 & 2019). The Environmental Protection Agency (2021) categorizes a typical urban collection truck as Class VII (26,001-33,000 lb) and readily defines GWP figures for diesel engines as 10.1280×10^{-3} kg CO_2 per a gallon. To allow for a general comparison, the truck model picked, a 4x2 Class VII ACMD XPERT, is one of the most popular models being implemented in urban areas around the United States (Autocar Truck, 2021).

Assumptions

Since data was collected based off a typical serving size for each prepared meal, there is an assumption that the average of daily calories after three meals is around 1,500 kilocalories for both male and female patients, which models hospital operation with most patients running a caloric deficit during their stay if only dependent on hospital meals. This includes an assumption that there is not necessarily a direct correlation with weight of food served and calories per a meal.

In terms of how the meals are put together, the simplest food items offered on the menu are chosen in an attempt to increase validity. Since the University of Wisconsin's menu served as the basis for choosing meals, the availability of the meal at other institutions was considered in the choosing meals in order produce results applicable to a wide array of institutions. Table 1 notes the diet type, time of day, and then the specific food's mass and caloric intake for that meal. The table does not account for the impact of cooking oils or additional seasonings that are not specified in the table. While beverages are included in the selected diets to provide a realistic view food mass produced per a patient, these food items are not included in the overall computation since composting facilities tend to omit liquids.

From *Food waste in hospitals: Review* (2018), it is estimated that about 30 percent of prepared hospital plates are thrown away after being received by the patient. This statistic was used to predict a general percentage of food waste produced per a plate. From this assumption, each food mass specific on each plate before waste reduction was decreased in mass by about 30 to 31 percent weight and then GWP is stated for the newly calculated mass.

Transportation figures become increasingly hard to predict for hospitals since the distance to the nearest compost facility varies greatly. In order to try and set a basis for data, the truck used in this study is always a 4x2 Class VII ACMD XPERT that always takes full loads to the facility (Autocar Truck, 2021). Also, it is significant that the noted truck is smaller than the average suburban municipal waste truck. This specific model carries less volume to composting facilities to account for tight turns within city blocks. The latter truck has the ability for the buyer to purchase the receptacle separately from the cab, so it is assumed that the average capacity of a receptacle this size is 8.658 metric tons based on bed size.

RESULTS

Food Waste GWP

When examining the results from Table 2, it is clear that the mass of food per a plate per a diet does not have as high of an impact on the GWP per a plate as what the plate is composed of. Tables 1, 2, and 3 illustrate the mass for each food which GWP is calculated as well as the GWP factor and resultant GWP. The plant-based plate has about 1.94 times as much material in grams as the plate that includes meat in order to meet the same caloric requirements (Alshqaqeeq, F., Twomey, J. & Overcash, M., 2018; USDA, 2021). The plant-based diet has an overall GWP of 1.03 x 10^3 while the diet containing meat products has a summed GWP of 9.21 x 10^3. This makes the GWP of the diet with meat about 8.94 times as impactful as the plant-based diet. Figure 1 visually presents the GWP of the diets. Since the average number of beds between Chicago's

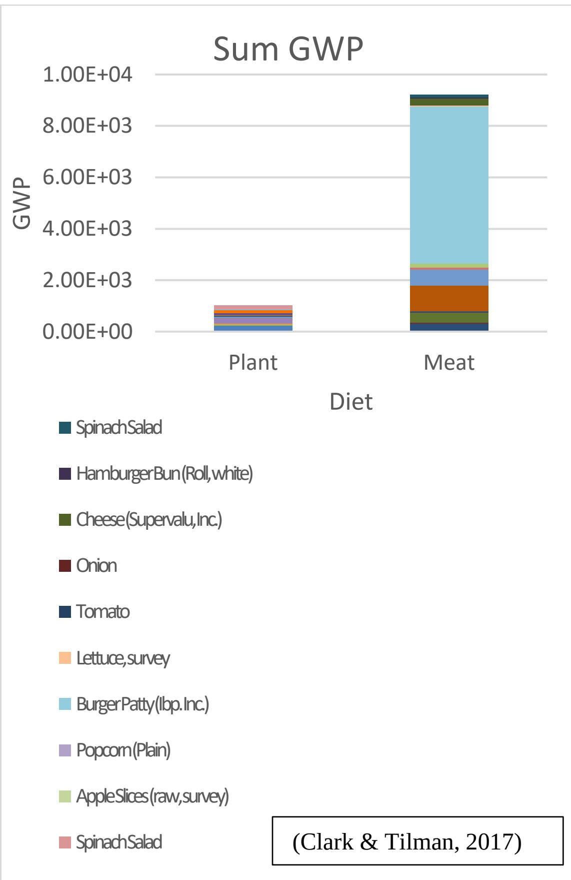

Figure 1. The total GWP per a day of meals analyzed by diet.

41 hospitals is 220 beds per location, a facility with equally split plant and omnivorous diets would produce about 252,241 grams of food waste with 78,194.71 grams, or 30 percent of the food being discarded. If the same facility had plant diet plates, there would be about 332,924 grams of totally food outputted, with 103,206.38 grams being discarded; an omnivorous diet would produce about 171,558.2 grams of food per a day and about 53,183.04 grams would be discarded.

Reduction Method GWP

Waste reduction was implemented in an attempt to decrease overall waste and emissions by proportionately shrinking the amount of product offered to the consumer by a factor of what is usually wasted. Within this scenario, the wasted amount assumed per a plate is about 30 percent of each ingredient. From this decrease in overall mass, the plant-based diet decreased overall mass by 543.832 g, and the diet including meat decreased by 84.668 g, which can be seen in in the comparison between Table 2 and Table 3. The overall GWP for the plant-based diet is 7.18 x 10^2 and the GWP for the diet including meat is 6.45 x 10^3. The latter GWPs illustrate a 30 percent decrease in impact for both diets, which correlates with the 30 percent decrease in mass. Again, the GWP presented with raw data is illustrated in Figure 2. As with the original food waste calculation, grams produced per average hospital bed gives insight into the weight of food outgoing into the system. If the hospital is assumed to have 220 beds, the amount of food waste for a split diet facility implementing waste reduction would be about 78,194.71 grams of food, the plant diet total food mass would be about 229,717.42 grams, and the omnivorous diet total food mass would be about 118,375.16 grams.

Transportation GWP

There are 41 hospitals considered to be within the Chicago area the average number of beds per a hospital being 220 beds between medical and intensive care, and the average mileage from each of these hospitals to the composting facility at 2000 South Rockwell Street (41.854742°, -87.690605°) is about 16.38 kilometers (Illinois Department of Public Health, 2019; University of Illinois Chicago, 2019). The North American Council for Efficiency (NACFE) has an online database that compiles the average miles per a gallon, which is converted in this study to liters, for Class VII and VIII trucks by state. Illinois' averages about 2.58 kilometers per a liter when this truck class is implemented for commercial use within this region (NACFE, 2018 & 2019). This mileage corresponds to an average trip using about 6.35 liters per a direction traveled. When computed, the GWP is about 1.71 x 10^{-1}

kilograms of carbon dioxide per a liter of gasoline (Table 4). Assuming hospital pickups would not need to happen more than once a week, the total GWP for a round trip computes as 1.09 kg of carbon dioxide equivalent.

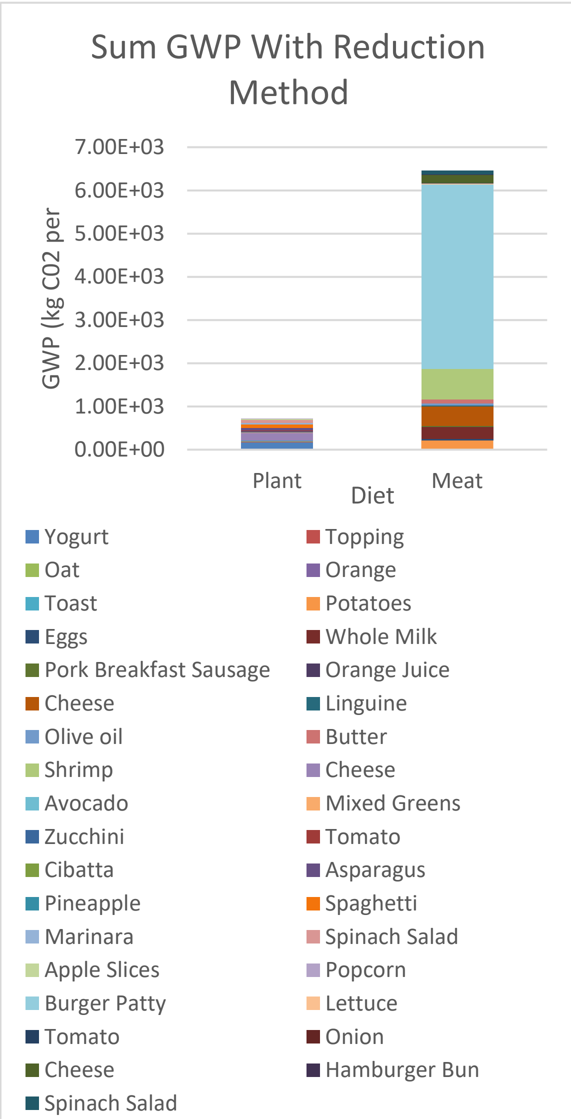

Figure 2. The total GWP per a day of meals based on diet after the implementation of waste reduction of 31%.

DISCUSSION

The results from this study make it is clear that the plant-based meals are greater in overall mass, but far lower impact with a GWP of 1.03 x 10^3 kg CO_2 equivalent per a gram of food. The omnivorous diet has a GWP of 9.21 x 10^3 kg CO_2 equivalent per a gram of food, which is 8.9 times more impactful than the plant-based diet. Since the average percentage of food wasted per a hospital plate is about 30 percent the waste reduction scenario had lower impacts for each plate, though the plant-based diet is still significantly lower in impact with a daily GWP of 7.18 x 10^2 kg CO_2 equivalent of food as compared to the omnivorous GWP of 6.45 x 10^3 kg CO_2 equivalent. This method does lessen the caloric density of a plate, but large facilities tend to under serve individuals (Alshqaqeeq, Twomey & Overcash, 2018). Also, the GWP of diets does fluctuate between mealtimes and diets, but the plant-based diet is continuously less impactful in every meal.

Transportation is a significant source of impact within this system as truck load and waste output are important considerations in fully understanding how engine use factors in overall. The GWP of a round trip is about 3.41 x 10^1. With the assumed capacity of the collection receptacle being 8.658 metric tons, it is important to note that a split diet hospital, with half of the beds following a plant diet and half following a omnivorous diet, would produce about 0.603 metric tons of waste within a seven-day period. Therefore, if a typical hospital follows the same assumptions, 14.35 more pickups could be run by the same truck until the truck's weight capacity is met. More likely, the truck would make multiple stops at various facilities. Information on specific waste pickup routes was unknown and study results would be improved by adding in this information. Furthermore, the plant-based diet is about 1.94 times as much mass as the omnivorous diet.

Compaction ability of the truck and density of the food within the receptacle effect the ability for more usable volume, so it is important to consider the possibility that some plant-based meals may take up more space in the truck if the same amount of food is wasted between the two plates. The volumetric ability of the collection vehicle is significant for analyzing impact seeing that a paritally filled truck would have a larger negative impact if the routes and masses per a hospital are not considered. For this reason, bed number per a hospital, a figure dependent on population density, is one of the most important indicators of possible GWP.

While a plant-based diet procures a significantly smaller impact than one containing meat, a facility focusing on encouraging plant choices will experience an increase in the amount of food needed to feed the same number of individuals. This is because plant-based meals tend to have a lower caloric density per kilogram. Also, an increase in shipments would need to be factored into the food's impact prior to reaching the facility due to the increase in mass of plant-based options, so further investigation into the difference in the tranportation impact would be required in order to understand possible downfalls of this diet. It is possible that the increase in shipments would require greater monetary allotment to transportation, but plant-based diets tend to require less costly materials, so a lower calorie count per a gram is expected and any money saved on meal ingredients can be added in to offset shipment cost.

When being sent to landfill, any food waste settling towards the bottom of the garbage heap will experience decay, which releases a significant amount of methane byproduct, a greenhouse gas 25 times more potent than carbon dioxide. The impact from decay identifies that a main goal of waste management should be to divert waste tonnage from being landfilled, but the current price per a ton to landfill is low when considering the price to compost, or even recycle (Amodeo & Collective Resource Compost, 2020). Notably, 30 to 40 percent of the United States food supply is wasted, which is around the range of reduction explored in this analysis (United States Department of Agriculture, n.d.). This commonality between waste percentages allows for these results to be considered on a bigger scale since reduction in GWP would be proportional.

Recycling is currently the most sought-after sustainability effort implemented by large facilities, but for facilities with large food waste production, it seems as though sustainability efforts may be better focused on composting programs. As urban areas continue to increase in density, it is vital that policy makers consider methods in which to mitigate the concommittant increase in food waste. Withough changes to current policy, food waste will be sent to the landfill due the low dump price per a ton, which then contributes heavily to methane production. This study provides information on the potential benefits of composting and meal planning to reduce waste. These are both options that provide environmental benefits and results from this study can be used by policy makers considering methods for reducing impact from food waste.

Currently recycling methods tend to be high cost environmentally and financially with minimal return due to inefficiencies within the current system (Al-Salem, Lettieri & Baeyens, 2009). Large facilities tend to possess the ability to more efficiently process waste as better systems as a results of funding decreases error (EPA, 2020). As seen within the study, there are clear differences in the impact of waste management techniques. It appears as though large urban facilities, such as hospitals, jails, and schools, would benefit from focusing on implementing composting efforts. Not only does composting have a significant positive environmental impact when considering its efficiency and the future usability of the composting product for agricultural production, but large facilities would monetarily benefit from focusing efforts in to reducing food waste and composting whatever waste is left. A combination of incorporating more plant matter into diets, reducing mass per a plate, and implementing composting efforts allows for facilities to better control their monetary contributions to waste management and reduce their environmental impact.

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Appendices

Food																	
Plant Based									Meat Based								
B			L			D			B			L			D		
Product	kcals	Mass per Serving (g)	Product	kcals	Mass per Serving	Product	kcals	Mass per Serving	Product	kcals	Mass per Serving	Product	kcals	Mass per Serving	Product	kcals	Mass per Serving
Parfait			Veggie Sandwich			Perfect Pasta			Scrambler			Linguine W Shrimp Scampi			Hamburger		
Yogurt	150	170	Cheese (semi-hard cheese, cheese, mozz, and cheddar cheese label used)- 1 slice	69.9	21	Spaghetti	250	150	Eggs (2)	147.2	100.6	ated Wholes	100	28	Burger Patty (Ibp. Inc.)	310	151
Topping for parfait (Blueberries)	42	80	Avocado/ 1.5 fruit	27.5	37.5	Marinara	60	125	Whole Milk (3TBS) Dean Foods Company	27.54	45.38	Shrimp (Sea Farms, Inc.)	80.2	113	Lettuce, survey	2.63	17.5
Granola	140	29	Mixed Greens (Lettuce)- 1/4 cup	8.24	8.74	Spinach Salad (raw, survey)	11.5	50	Pork Breakfast Sausage	110	56	Cheese	200	56	Tomato	10	40
Toast (WONDER)	120	46	Zucchini, Baby, Raw	7.5	50	Apple Slices (raw, survey)	108	200	Orange Juice (Tropicana, 85% orange juice assumed)	106	225	Olive Oil, survey	62	7	Onion	19.73	49.33
Hashbrowns			Tomato- 3 slices	15	60	Popcorn (Plain)	135	28				Butter, survey	100	14	Cheese (Supervalu, Inc.)	80.1	22
Potatoes	150	28	Cibatta (WHEAT USED AGAIN)	250	100	Unsweeten ed Ice Tea	0	240 (mL)	Hashbrowns			Unsweeten ed Ice Tea	0	240 (mL)	Hamburger Bun (Roll, white)	145	52
Orange	72.4	154	Asparagus	22.4	112				Potatoes	150	28						
Coffee	2.4	240	Pineapple	41.25	82.5										Spinach Salad	11.5	50
			Tea	2.4	240 (239g H20)										Unsweeten ed Ice Tea	0	240 (mL)

Table 1. Depicts the chosen meals and their caloric value with correlating mass. This information was gathered through the University of Wisonsin's menu and Food Data Central.

GWP per G							
Plant-Based				Meat-Based			
Food	G per Serving	AVG Factor(GWP per a g)	GWP	Food	G per Serving	AVG Factor	GWP
Yogurt (survey)	170	1.41E+00	2.40E+02	Eggs (2)	100.6	3.03E+00	3.04E+02
Topping for parfait (Blueberries , survey)	80	1.13E-01	9.04E+00	Whole Milk (3TBS) Dean Foods Company	45.38	1.12E+00	5.09E+01
Granola (Oat, survey)	29	7.70E-01	2.23E+01	Pork Breakfast Sausage, suvey	56	6.99E+00	3.91E+02
Toast (WONDER, wheat, ~20% of bread is wheat)	9.2	7.12E-01	6.55E+00	Orange Juice (Tropicana, 85% orange juice assumed), survey	191.25	1.61E-01	3.07E+01
Potatoes, survey	28	1.53E-01	4.29E+00	Linguine (Associated Wholesale Grocers, Inc)	28	7.12E-01	1.99E+01
Orange, survey	154	1.61E-01	2.47E+01	Shrimp (Sea Farms, Inc.)	113	8.74E+00	9.88E+02
Cheese (semi-hard cheese, cheese, mozz, and cheddar cheese label used)- 1 slice	21	1.15E+01	2.41E+02	Cheese (semi-hard cheese, cheese, mozz, and cheddar cheese label used)- 1 slice	56	1.15E+01	6.44E+02
Avocado/ 1.5 fruit, survey	37.5	1.66E-01	6.23E+00	Olive Oil, survey	7	8.54E+00	5.98E+01
Mixed Greens (Lettuce)- 1/4 cup	8.74	1.64E+00	1.43E+01	Butter, survey	14	1.09E+01	1.52E+02

Table 2.1. Depicts the grams of food per a serving, the average factor, and then resulting GWP for the plant diet versus the omnivorous diet (Clark & Tilman, 2017).

Zucchini, Baby, Raw	33	1.21E+00	4.01E+01	Burger Patty (Ibp. Inc.)	151	4.05E+01	6.12E+03
Tomato (not tree tomato)- 3 slices survey	60	3.80E-01	2.28E+01	Lettuce, survey	17.5	1.64E+00	2.87E+01
Cibatta (WHEAT USED)	20	7.12E-01	1.42E+01	Tomato, survey	40	3.80E-01	1.52E+01
Asparagus	112	6.76E-01	7.57E+01	Onion	49.33	5.06E-02	2.50E+00
Pineapple	82.5	9.76E-02	8.05E+00	Cheese (Supervalu, Inc.)	22	1.15E+01	2.53E+02
Spaghetti, curvey	150	7.12E-01	1.07E+02	Hamburger Bun (Roll, white)	52	7.12E-01	3.70E+01
Marinara (Tomato data used)	125	3.80E-01	4.76E+01	Spinach Salad	50	2.30E+00	1.15E+02
Spinach Salad	50	2.30E+00	1.15E+02				
Apple Slices (raw, survey)	200	1.02E-01	2.04E+01				
Popcorn (Plain)	15	4.16E-01	6.25E+00				

Table 2.2. Table 4.1 continued.

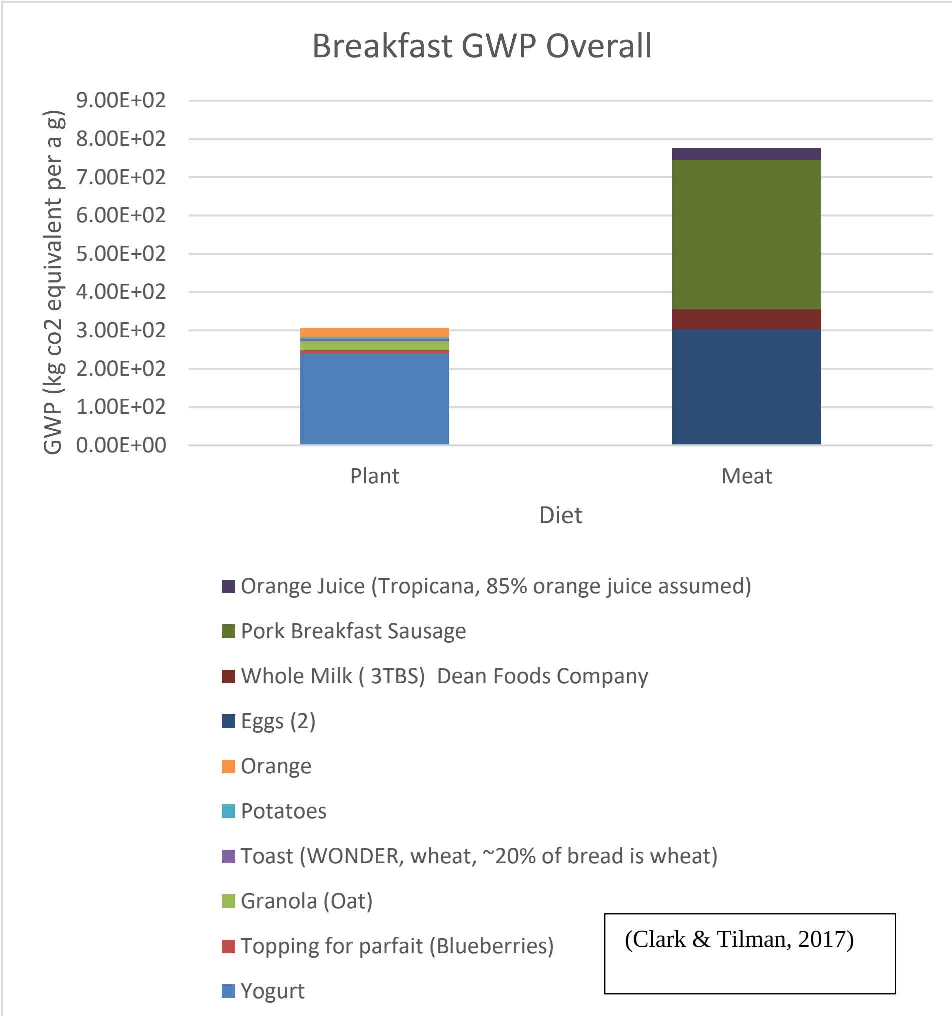

Figure 3. Depicts the GWP for overall food waste produced for breakfast by diet.

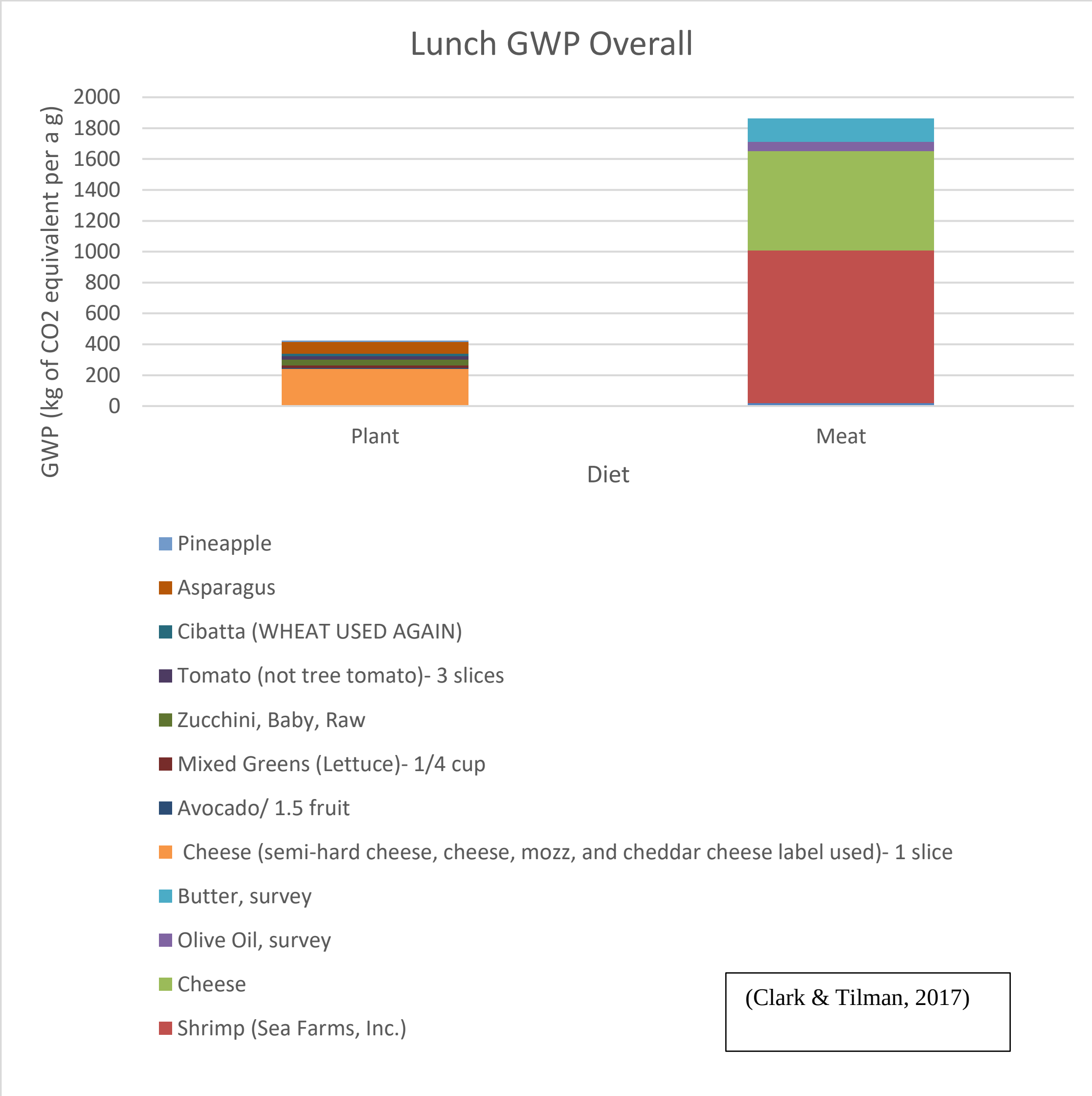

Figure 4. Depicts the GWP for overall food waste produced for lunch by diet.

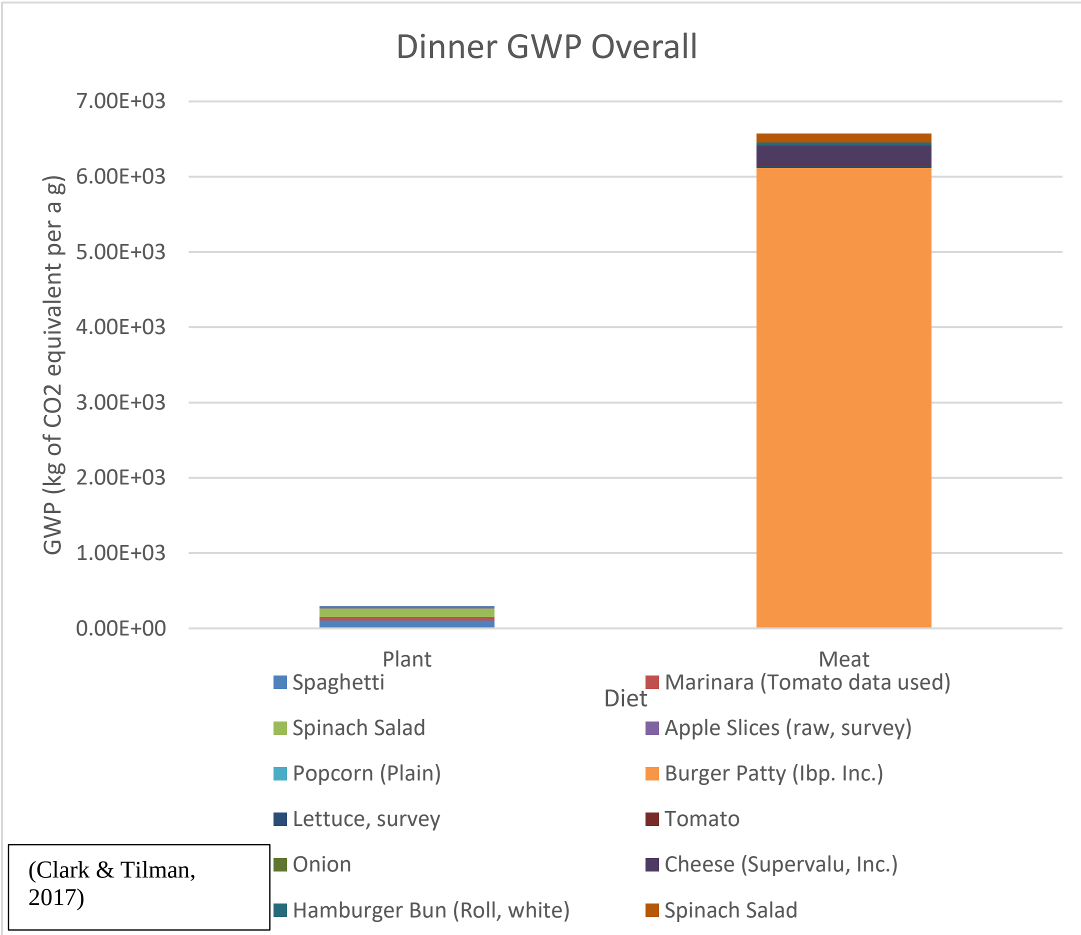

Figure 5. Depicts the GWP for overall food waste produced for dinner by diet.

GWP w Reduction Method											
Plant						Meat					
Food	G per Serving	30 percent	New Mass	AVG Factor(GWP per a g)	GWP	Food	G per Serving	30 percent	New Mass	AVG Factor	GWP
Yogurt	170	51	119	1.41E+00	1.68E+02	Eggs (2)	100.6	30.18	70.42	3.03E+00	2.13E+02
Topping for parfait (Blueberries, survey)	80	24	56	1.13E-01	6.33E+00	Whole Milk (3TBS) Dean Foods Company	45.38	13.614	31.766	1.12E+00	3.56E+01
Granola (Oat, survey)	29	8.7	20.3	7.70E-01	1.56E+01	Pork Breakfast Sausage, survey	56	16.8	39.2	6.99E+00	2.74E+02
Toast (WONDER, wheat, ~20% of bread is wheat)	9.2	2.76	6.44	7.12E-01	4.59E+00	Orange Juice (Tropicana, 85% orange juice assumed)	191.25	57.375	133.875	1.61E-01	2.16E+01
Potatoes, survey	28	8.4	19.6	1.53E-01	3.00E+00	Linguine (Associated Wholesale Grocers, Inc)	28	8.4	19.6	7.12E-01	1.40E+01
Orange, survey	154	46.2	107.8	1.61E-01	1.74E+01	Shrimp (Sea Farms, Inc.)	113	33.9	79.1	8.74E+00	6.91E+02
Cheese (semi-hard cheese, cheese, mozz, and cheddar cheese label used)- 1 slice	21	6.3	14.7	1.15E+01	1.69E+02	Cheese (semi-hard cheese, cheese, mozz, and cheddar cheese label used)- 1 slice	56	16.8	39.2	1.15E+01	4.51E+02
Avocado/ 1.5 fruit. survey	37.5	11.25	26.25	1.66E-01	4.36E+00	Olive Oil, survey	7	2.1	4.9	8.54E+00	4.18E+01
Mixed Greens (Lettuce)- 1/4 cup	8.74	2.622	6.118	1.64E+00	1.00E+01	Butter, survey	14	4.2	9.8	1.09E+01	1.07E+02

Table 3.1. Depicts the grams of food per a serving, the average factor, and then resulting GWP for the plant diet versus the omnivorous diet after waste reduction (Alshqaqeeq, Twomey & Overcash, 2018; Clark & Tilman, 2017).

Zucchini, Baby, Raw	33	9.9	23.1	1.21E+00	2.80E+01	Burger Patty (Ibp. Inc.)	151	45.3	105.7	4.05E+01	4.28E+03
Tomato (not tree tomato)- 3 slices	60	18	42	3.80E-01	1.60E+01	Lettuce, survey	17.5	5.25	12.25	1.64E+00	2.01E+01
Cibatta (WHEAT USED AGAIN)	20	6	14	7.12E-01	9.97E+00	Tomato, survey	40	12	28	3.80E-01	1.06E+01
Asparagus	112	33.6	78.4	6.76E-01	5.30E+01	Onion	49.33	14.799	34.531	5.06E-02	1.75E+00
Pineapple, survey	82.5	24.75	57.75	9.76E-02	5.64E+00	Cheese (Supervalu, Inc.)	22	6.6	15.4	1.15E+01	1.77E+02
Spaghetti, survey	150	45	105	7.12E-01	7.48E+01	Hamburger Bun (Roll, white)	52	15.6	36.4	7.12E-01	2.59E+01
Marinara (Tomato data used)	125	37.5	87.5	3.80E-01	3.33E+01	Spinach Salad	50	15	35	2.30E+00	8.05E+01
Spinach Salad	50	15	35	2.30E+00	8.05E+01						
Apple Slices (raw, survey)	200	60	140	1.02E-01	1.43E+01						
Popcorn (Plain)	15	4.5	10.5	4.16E-01	4.37E+00						

Table 3.2. Table 5.1 continued.

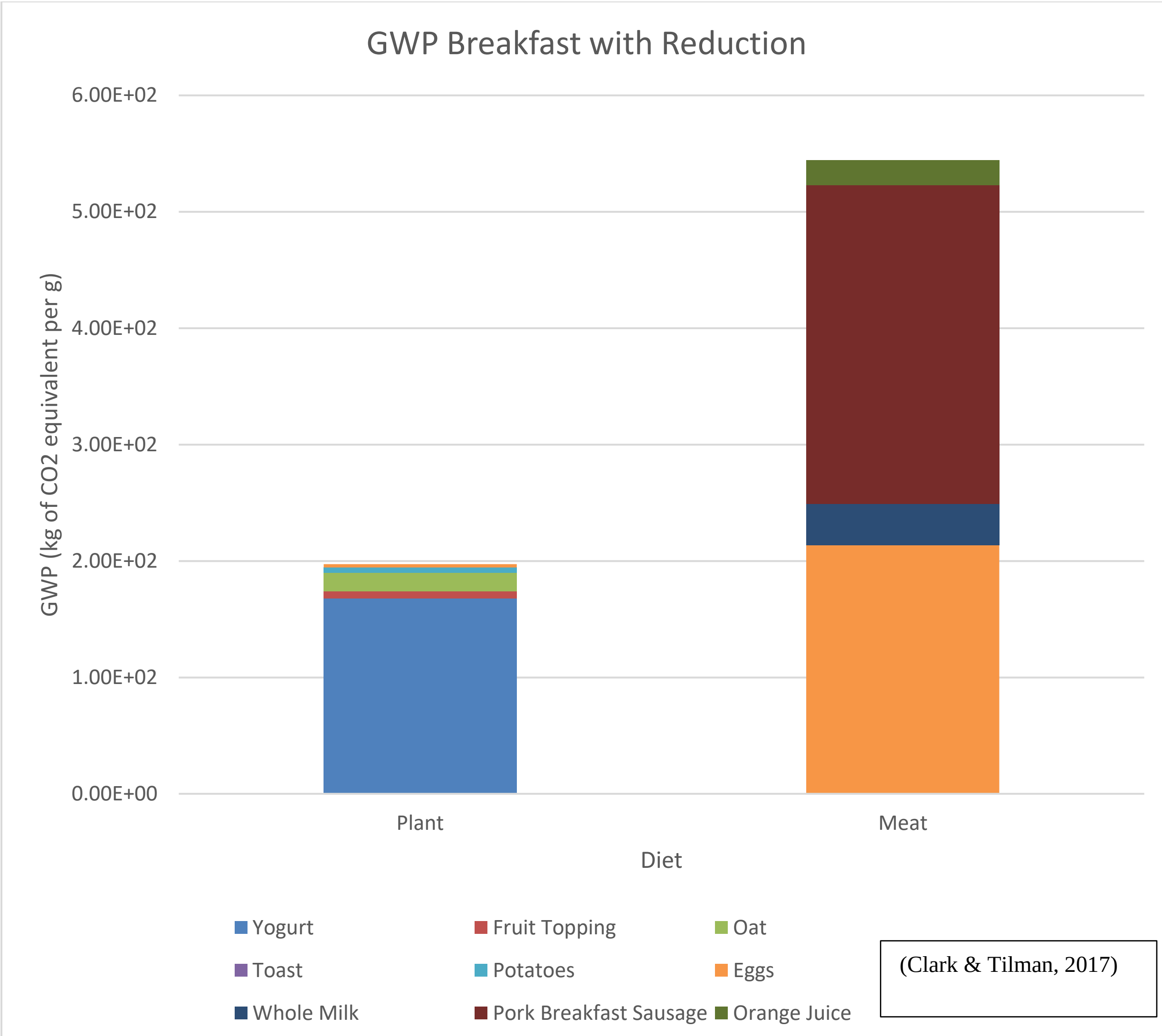

Figure 6. Depicts the GWP for overall food waste produced for breakfast by diet after waste reduction.

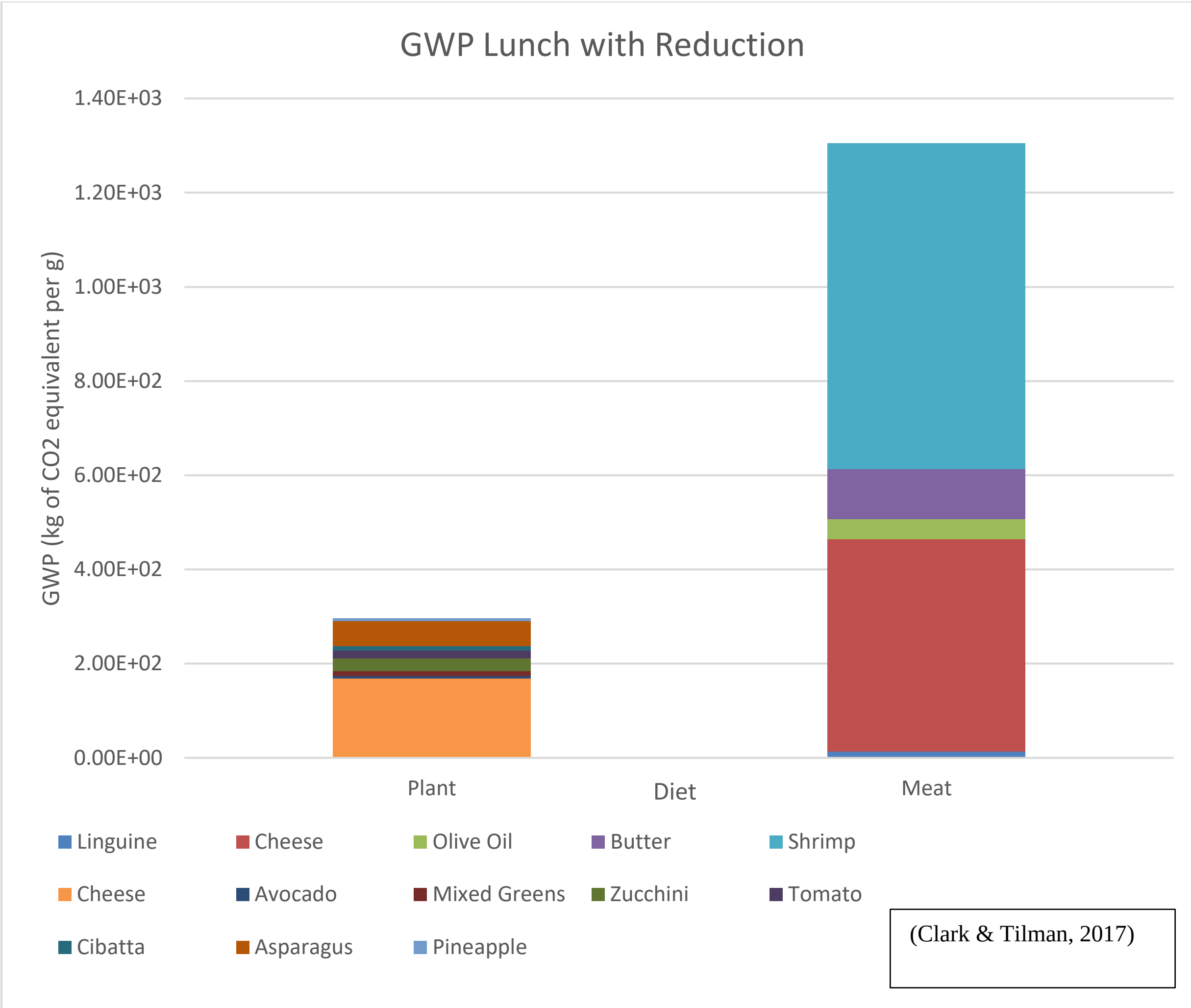

Figure 7. Depicts the GWP for overall food waste produced for lunch by diet after waste reduction.

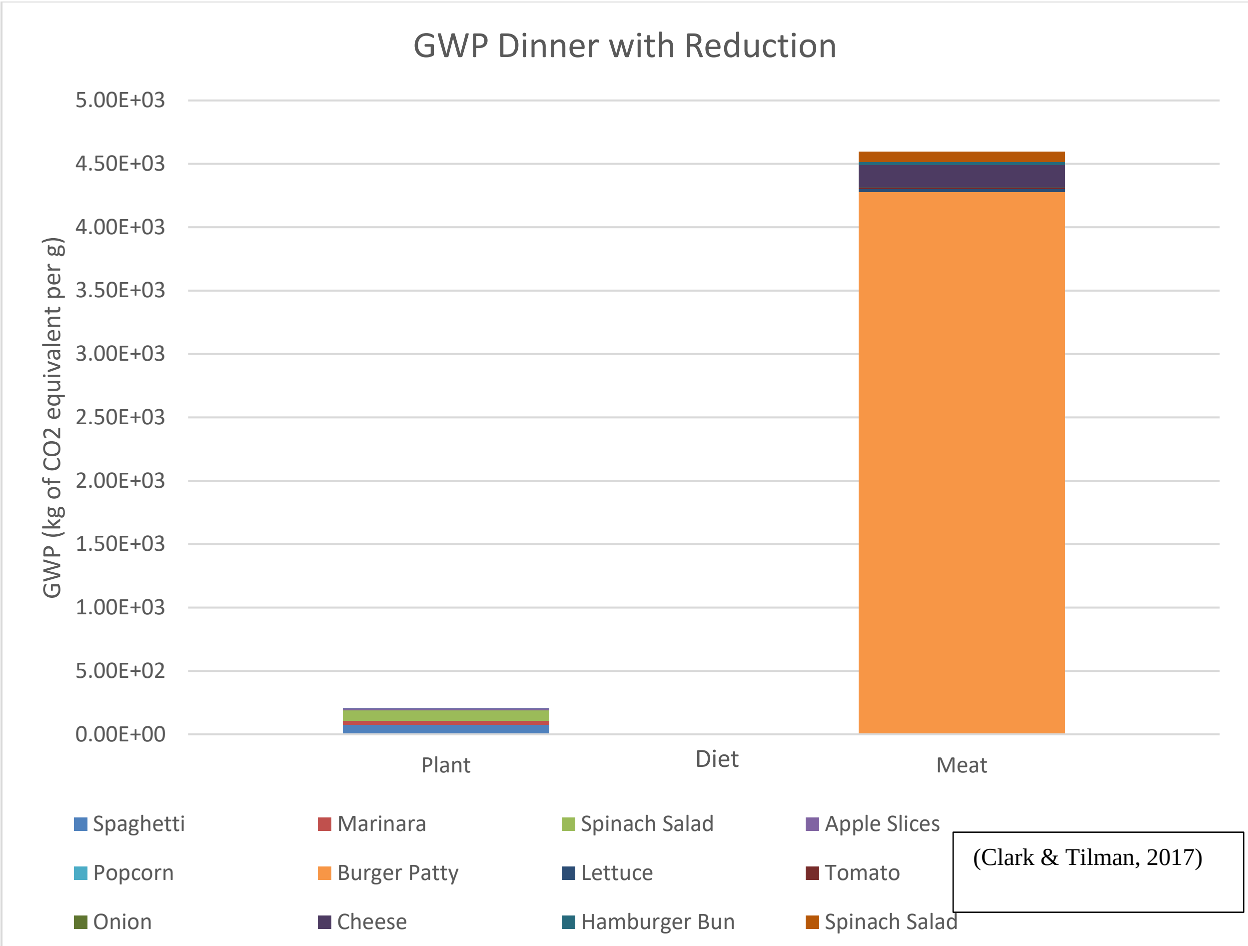

Figure 8. Depicts the GWP for overall food waste produced for dinner by diet after waste reduction.

Average to Compost Heap (km)	Illinois AVG MPG for Class VII and VIII (km/L)	Liters Used	Equivalent Factor (kg CO2 per gal of gasoline)	GWP (kg CO2 per gal of gasoline)	Round Trip GWP
16.38312	2.58	6.34849621	2.68927986	17.072883	34.145766

Table 4. The calculations in order to figure out the GWP of round trip (not including distance in between hospitals) (EPA, 2021).