DEWATERING METHOD FOR FOOD AND KITCHEN WASTE

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ABSTRAK

Pengurangan sisa dari isi rumah dapat mengurangkan kebergantungan dan beban ke tapak pelupusan sampah. Proses penyahairan adalah satu cara untuk memisahkan zarah cecair dalam makanan dan sekerap dapur untuk mengurangkan jumlah air bebas dan terikat muncul dalam komponen makanan dan tumbuhan. Tujuan kajian ini adalah untuk menentukan kebolehan pengering spin domestik untuk mengurangkan peratusan kandungan lembapan sisa dapur dengan menggunakan daya centrifugal. Pelupusan sisa yang digunakan untuk memecah saiz zarah memudahkan proses pemisahan zarah cair dalam zarah pepejal. Jenis makanan dan sisa dapur khas di Malaysia digunakan sebagai parameter dalam projek ini. Perbandingan tahap kelembapan sebelum dan selepas proses penyahairan ditentukan untuk mengenal pasti jumlah kelembapan yang berlainan dalam sisa selepas 5 minit mencarik dan proses penyahairan. Kehilangan sampah semasa proses penyahairan juga ditentukan sebagai penunjuk keberkesanan proses ini dalam mengurangkan pengeluaran sisa dari sumber. Pengurangan ketara kira-kira 50% -80% daripada berat awal sisa selepas penyahairan selama 5 minit menunjukkan sistem ini mampu mengurangkan pengeluaran sisa dari dapur sebelum dibuang ke tapak pelupusan sampah. Produk ini keluar dari proses penyahairan boleh dihuraikan dan digunakan dalam pengeluaran makanan haiwan. Reaksi sisa semasa proses pengkomposan diperhatikan untuk menganalisis perbandingan pertumbuhan mikrob semasa pembajaan sisa mentah dan sisa buangan. Berdasarkan pengurangan sisa dan pengkomposan, proses penyembuhan dianggap sebagai kaedah yang sesuai digunakan dalam pengurusan sisa pepejal.

ABSTRACT

Reduction of waste from the household can decrease the dependency and burden to landfills. Dewatering process is a method to separate liquid particles in food and kitchen scrap in order to reduce the amount of free and bound water appear in the component of food and plant. The purpose of the study is to determine the ability of domestic spin dryer to reduce the percentage of moisture content of kitchen waste by applying centrifugal force. The waste disposer used to break down the size of particles simplify separation process of liquid particles in solid particles. Type of typical food and kitchen waste in Malaysia are used as parameter in this project. Comparison of moisture level before and after dewatering process is determined to identify the different amount of moisture remain in waste after 5 minutes shredding and dewatering process. The waste loss during dewatering process also determined as an indicator of the effectiveness of this process in reducing the production of waste from source. The significant reduction about 50% -80% from initial weight of waste after 5 minutes dewatering shows this system is able to decrease waste production from the kitchen before being dumped to landfill. The product comes out from dewatering process can be decomposed and used in animal feeding production. The reaction of waste during composting process is observed to analyze the comparison of microbial growth during composting raw waste and dewatered waste. Based on the reduction of waste and composting, the dewatered process was considered as a suitable method used in solid waste managemen

CHAPTER 1

INTRODUCTION

1.1 Research background

Food waste becomes a huge problem faced by human nowadays around the world. Food waste usually dominates a large portion of municipal solid waste either in developed and developing country and contribute in spreading environmental problems such as water and air pollution that comes from unmanageable solid waste when it landfilled [1]. Amount of solid waste produced increasing by the year, about 90 million of solid waste comes from industrial, municipal, agricultural and food processing. Water that contaminates by municipal solid waste too heterogeneous since it contains much household waste from public utilities and industries.

Residual household waste means a combination of waste produce remains in the household after separating hazardous waste and recyclable waste such as biowaste, paper, cardboard, metals, glass, and waste electrical and electronic equipment [2]. The food waste usually involves the production of food product that generates waste at different kind of process chains such as handling, processing, and food source including fruits, vegetables, uncooked raw materials, and food waste from houses and restaurants. Improper management practice in the community is one of the main cause of food waste not treated well and landfill as the last choice to solve this problem.

Regular domestic waste generally contains various type of food that comes from the kitchen and uneaten food. It has dominated a large portion of solid waste rather other organics waste which consist of wood, garden waste, paper, textiles, rubber, leather and other material which can disposal in a natural way. The increased volume of food waste produced annually by agricultural practices, improper food transportation and storage, and human activities. In Malaysia, landfilling remains as an option for household waste disposal. 80% of the overall weight of solid waste comes from food which as main components of Malaysian waste[3]. Open dumping by most landfill contributes critical

environmental problems such as soil, water, and air pollution. Furthermore, other ways to dispose of waste is incineration which most popular in many countries. Controlled combustion of waste with recovery generated from incineration used to produce pressure steam in order to generate power from steam turbine [4]. Although it can use as a source of generating power, however incineration have a negative impact on the environment when the emission occurred emits heavy metal, high carbon dioxide, and furans which causes serious human diseases and danger to greenhouse gases. Open dumping practices in the river and drain which causes acidification of local ecosystem thus attributes the pollution of water.

1.2 Problem statement.

It is needed to find an alternative way to handle domestic waste that is produced in the household since it often uses landfills as a predominant waste management option for waste disposal. The rising of Malaysian population annually, the generation of municipal solid waste also increases. In the future, the landfill cannot support a large population which increases by the year.

The household waste generally made up of the wettest component waste stream with high moisture content up to 75-85 % which contribute the main source of decay, odor, and leachate in collection and transportation due to its high volatile solids. Unmanageable treatment can cause odors pollution and water pollution. However, different types of household waste have a different percentage of moisture content.

Waste disposer has been introduced as a new method to dispose waste from kitchen waste. The waste disposer chops the waste become small size and discharge to the drain. Even it can use as a solution to reduce the waste produced from the source, however, it can cause clogging in the channel in the drain and lead to increase the solid suspended in the water. Domestic composting and anaerobic digestion are both processes that can be applied to the household however, it creates more problems such as odours and greenhouse emission. Removing water content can reduce the quantity of putrescible fraction of food waste significantly[5]. Thus, selective of dewatering method is applied to overcome this problem.

1.3 Objective.

1. To develop a method to reduce the percentage of moisture content in domestic waste at source in short time.
2. To reduce the amount of waste produced at the source before being dumped to landfill by utilizing low-cost device.

1.4 Scope of work.

1. Analyze composition and moisture content of waste that will use for dewatering process.
2. Compare the different of reduction of waste and moisture level after shredding and dewatering.
3. Analyze drying rate between raw waste and dewatered waste in drying process.
4. Compare condition between dewatering and raw waste during composting.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The food waste causes a large environmental problem. A. Sotiropoulos expects that the food waste is will increase significantly according to population growth and rising in consumption[5]. The waste private household is a largest food waste fraction in the food supply chain. Currently, the available disposal option such as landfilling remains the main option in society in waste management since there is a limited innovation of new technology for waste management at source. Furthermore, other ways to dispose of waste are incineration which is not popular in many countries which can cause greenhouse gases and open dumping practices in the river and drain can contribute acidification of local ecosystem thus attributes the pollution of water. Therefore, it needed to find a new alternative way to treat biodegradable waste produced from source.

2.2 Food waste components.

Food waste can be categorized into three categories which are food loss, unavoidable food waste, and avoidable food waste. Food loss cause by losing food amount during the production phase. Different to food loss, unavoidable food waste stems by the loss of food products during the consumption phase. Avoidable food waste refers to products that could have been eaten but lost during consumption phase. The household has observed to have huge food waste fraction among another source of food waste. Karin has stated, daily routine and practice such as shopping, storing, cooking, eating and managing leftovers influence the food waste generation from household [6].

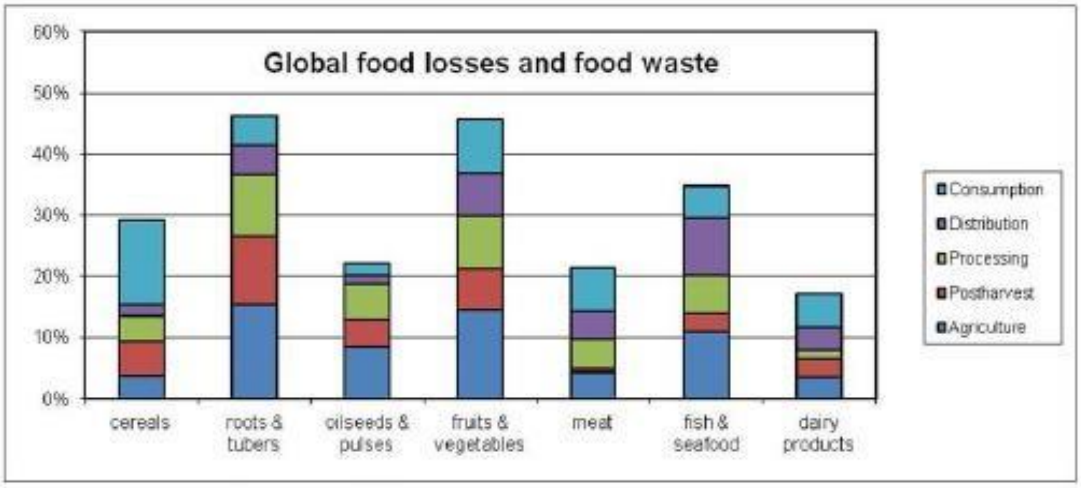


Figure 2.1: Statistic of global food losses and food waste in 2010[7].

Variation in composition of food waste strongly depends on the cultural differences in food habits and variation in locally available produce. Different cultural of eating ways depends on places, weather, and availability of food source. Mostly the composition of food waste in rich in carbohydrates, protein, and lipids, which have different theoretical methane yields[7]. Typical food waste in Malaysia consists of 70% water from overall weight.

2.3 Dewatering.

Dewatering is a process of removing water from solid component by centrifugation, filtration or similar solid-liquid separation process to produce the filter solid cake with lower moisture. This process needs external forces or sometimes shear compressive force applied directly to the solid phase. The solid-liquid separation process has been implemented in a different method based on types of material used and material characteristics.

Most common dewatering process has been applied in wastewater treatment. Sludge residue from water treatment spent a lot of costs to store and transport to a disposal site. The disposal of sludge requires an extensive amount of energy and transportation method that often relies on gases that contribute to carbon emission. Since it also rich in water content (99 - 96.3 %), perishable organics, pathogens, and hazardous

material[8]. The dewatering as a viable solution to treat the wastewater effectively since it can reduce environmentally harmful material from the water.

The dewatering system has utilized in the separation of liquid and solid components for waste minimization. This method is not used to treat the sludge or liquid, however it a method for easier and more cost-effective to handle the separate phases for final disposal. This dewatering sludge typically focused on reducing the mass and volume of sludge, simultaneously convert organic matter to biogas for bioenergy source. Various sludge dewatering technologies have been applied in diverse treatment and dewatering plants globally.

However, the suitable option for individual sludge is based on an understanding of the reaction of sludge composition and properties after each method of dewatering [9]. In this case, the dewatering system is focused on food waste management. The dewatering process help to reduce the moisture content by extraction. Currently, common dewatering processes use mechanical mechanism means of separation, such as screw presses, belt presses, vacuum filters, hydraulic press, and centrifuges, which can all be combined with additional forces to remove the water, such as an electric field, ultrasonic, vibrations, chemical treatments and hydraulic pressing [10].

2.4 Selecting dewatering method.

There are different types of dewatering methods are used as water removal for food waste. The selection of dewatering method for food waste must be considered parameters that can affect the dewatering product and wastewater produced after dewatering process. Among the parameters involved in the selection, proper prediction of dewatering rates in particles and dewatering times during dewatering process are required.

a) Centrifugal dewatering.

One of the alternative methods is centrifugal dewatering method. This method uses the rotating force to separate the liquid from solid particles. It applied strong force perpendicular to the axis of spin. Most the centrifugal dewatering concept has applied for the dewatering sludge. Centrifuge dewatering can be the best option among other dewatering methods depending on the type of material used to be dewatered. The centrifugal dewatering method could be suitable compared to mechanical compression for material that can be easily damaged[11].

Fukuyama illustrated how the centrifugal dewatering process deforms the incompressible cake. In this method, after the centrifugal dewatering begins, the liquid cake interface starts to appear in a certain duration of time. This process is known as supernatant spread which appears though cake layer. A consolidation process will undergo affect the form of cake thus the cake become shrinkage when supernatant is entirely released through the cake. The corresponding capillary force is produced by solid particles at the surface. The liquids are dragged in the direction of centrifugal force because of effect reaction force acting on liquid particles[12].

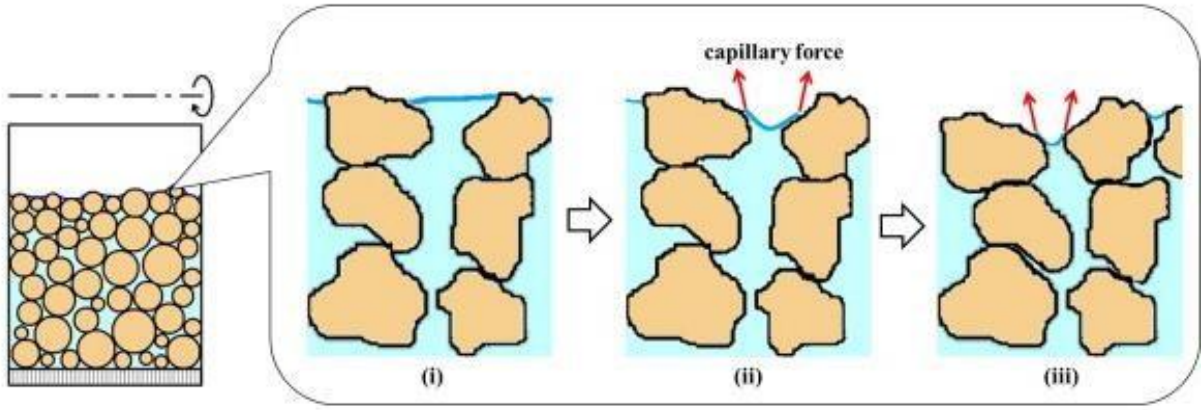


Figure 2.2: The consolidation mechanism appears at the cake surface during dewatering. (i) liquid surface is flat at the entrance of flow channel of cake (ii) the meniscus upper surface presented due to capillary force. (iii) the liquid particles are dragged in the direction of centrifugal force [10].

The thickness of cake deformation is also influenced by the centrifuge force applied to them. Since the higher rotational speed used, the consolidation of cake becomes less thick because of the disappearance of supernatant in the particles.

b) Hydraulic press dewatering

Pressing is one of the process to separate fluids from solid particles by utilizing compress force. The hydraulic press dewatering is designed as a device to extract the fluids from solid matter. This system has applied for the latex quantification in plant species to separate the fluids by pressing plant tissues. This pressing system has reduced the moisture content almost 75.6% from the initial level [13].

The hydraulic cylinder is controlled by the hydraulic pump and the press plate that is attached on the end of the hydraulic cylinder to press the plant in the cylinder. Press efficiency is defined as the amount of fluids collected following pressing. Although it has excellent in separating the liquid from solid, the cost of construction of this machine is expensive which is approximately $2000.

c) Screw press dewatering.

The innovation dewatering product offers many advantages over conventional waste management methods. Screw press is a device used to separate the liquid from solid. It has been used widely as vegetable oil extraction from oilseeds. This system uses breakage mechanism based on squeezing the material against the filter.

It is suitable for material which is hard to press. The screw press consists of the barrel in which a conical screw rotates and presses the seeds by pressure. The volume is reduced and the oil is compressed through the seed mixture and the unoiled press cake is discharged at the end of the screw [14]. However, the experiment shows that defatted flour produced from ground press cake using screw press contain higher moisture level compared to hydraulic press[15].

d) Belt press dewatering.

The belt press is commonly used in dewatering the most biosolid generated municipal wastewater treatment plant. This device is used to remove waste water from solid waste residual and produce solid paste like cake. The belt filter presses consist of general mechanical components such as dewatering belts, rollers and bearings, belt tracking and tension system, controls and drives, and belt washing system. It utilizes pressure to the biosolids to squeeze out the wastewater [16]. The experiment was conducted by Kansas University by using belt filter to dewatering the microalgal at low 10g dry wt. /L concentration of microalgal suspension.

From the studies, the system could recover the concentration of microalgal as low as 6 g dry wt. /L effectively by improving the dewatering efficiency of the system. In this case, the percent of microalgal recovered is depends on the effect of machine parameters such as filter feed rate and belt speed[17].

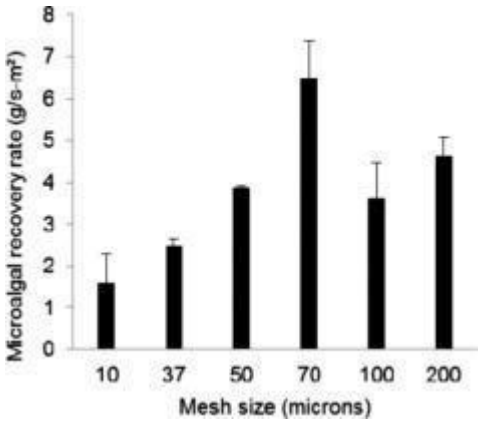


Figure 2.3: Determination of mesh size of belt filter with the highest microalga recovery rate [17].

The selection of dewatering method is based on the ability of the machine works with high moisture content material. Fukuyama studied that the centrifuge dewatering is one of the effective methods in solid-liquid separation which used in many industries [12]. Besides, cost of manufacturing also become a factor in selecting affordable dewatering equipment.

2.5 Types of shredder.

In order to increase the efficiency of dewatering process, the reduction of particle size is important to consider. The smaller size of particles takes less time to separate liquid from solid than large ones because of lower moisture content and the moisture can be easily transported to the surface due to shorter pathway [18]. The shredded waste can reduce the amount of moisture level when it cut up into small pieces compared to larger pieces because of the larger total surface area for mass transfer. The selection of shredder types gives the impact of the time consumed to dewatering process.

A recent study has developed the size reduction unit which in common use in municipal solid waste management. Hammermill crusher is used to hit the solid waste with sufficient force to crush and it suitable for the brittle material. However, the hammer crusher has difficulty in breaking the ductile and moisture material because of interrupt the stress transfer that causing a high amount of energy disappear due to softening mechanisms. In comparison, lab scale shredder is designed to breakage ductile material ineffective way.

The material is compressed by pusher that is connected to the hydraulic piston and meshed by rotating blades and shear blades to produce fine particles. The rotating blades and the comb-shaped shear blades are affected by pulling, shearing and meshing process. However, this kind of shredder is suitable for large scale of solid waste and need more cost on manufacturing and maintenance [19].

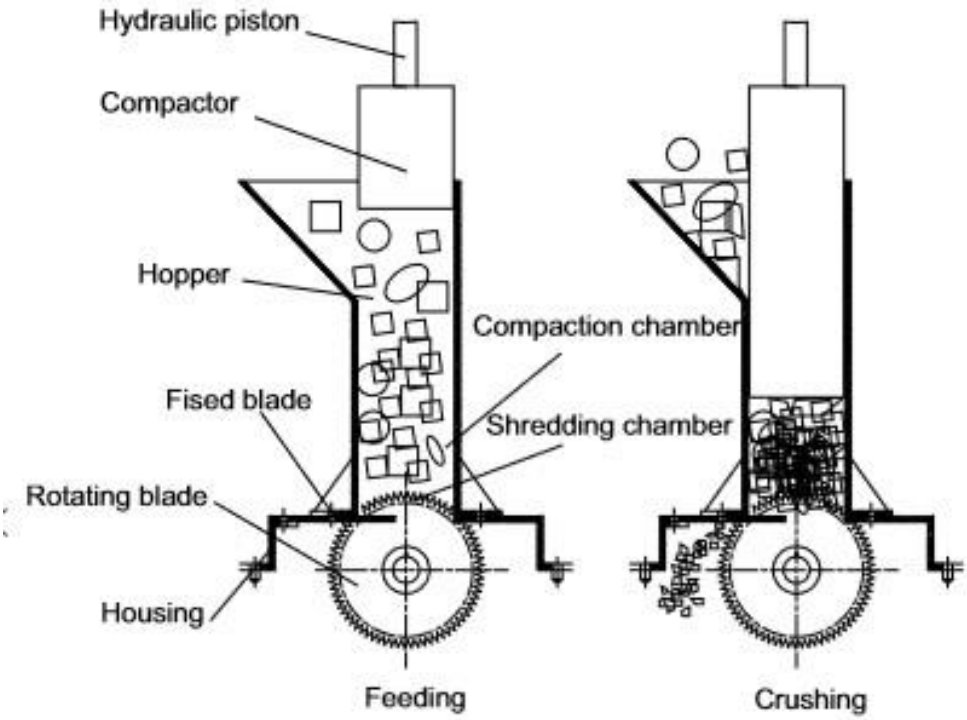


Figure 2.4: Operating principle of hammer shredder consisted of compaction and shredding chamber. [19]

2.6 Moisture content in food and kitchen waste.

Moisture content is the amount of water present in a substance. Most living matters consists of water as a primary component in their structure. A significant function of water in a living thing is for supporting animal and plant to grow well in their life. Most food product comes from living thing and has different moisture level depends on source and process to in making the food product. The excessive food from the kitchen, food manufacturing, and food processing has become food waste which is rich in moisture content almost 70 % - 85 % [20]. Furthermore, food waste from fruits and vegetable have higher moisture level. The higher moisture content can cause environmental problems, odor nuisance and larval growth thus it is difficult to manage properly compared to dry waste. Thus, lower moisture content in food waste as an alternative way to overcome the problem in solid waste management. By reducing moisture present in substance can help in the composting process and animal food product.

Table 2.1: Composition (%) of food waste on wet weight basis [21]

Components	Malaysian food waste	Japanese food waste (Ohkouchi & Inoue, 2007)
Moisture	78.09	77.5
Ash	1.42	1.68
Total Sugar	10.36	9.85
Carbohydrate	8.05	7.79
Protein	3.50	3.99
Fats	5.22	5.41
Fiber (cellulose, lignin, hemicelluloses)	4.64	4.72

Note: Malaysian food waste data is taken from a laboratory work by the author to study food waste composition from a household in Malaysia. The above data is not regarded as representative of the whole countries' food waste composition but only used as a sample reference.

2.7 Filter material.

The significant of the filter is removing impurities or solid particles from liquid passed through it. It prevents the part of fine solid and allows wastewater to pass through easily. The material for the filter can be variety of material such as nylon, cloth, poly fabric and Dacron fabric which commonly used in producing juice. From the previous study have a concern that the filter made from cloth is the best choice to enhance filter performance [22]. The filter cloth has good resistance to mechanical damage by either component in the feed or by operation of the filter and good cake discharge from the cloth.

Table 2.2: Cloth types for filter in dewatering [22].

Filter type	Filter cloth types	Filter media/filtration characteristics
Municipal sludge		
Filter press	Mono-polyester; mono-polyamide; staple polyamide; staple polypropylene; mono-polypropylene; mono-polyvinylidene chloride	Good resistance to blinding and mechanical damage; good cake discharge
Belt filter	Mono-polyester	High stability for good tracking; strong belt jointing; high mechanical resistance
Industrial sludge		
Filter press	Mono-polyester; mono-polyamide; staple polyamide; multi-warp/staple weft polypropylene	Good cake discharge; fine particle retention; high throughput

2.8 Composting of food and kitchen waste.

Composting is one of method that has practices among in developed country as biological degradation of the organic matter and it occurs under aerobic and anaerobic condition[23]. It is as an alternative waste disposal method which biochemical process changing various type of components in organic waste into relatively stable humus substances that can used as a soil amendment or organic fertilizer [24]. However, composting process in food waste causes many challenges since it from highly heterogeneous material with high moisture content, high organic to ash ratio and an amorphous physical structure. Thus, mistakes in the initial preparation and modification of the mixture with bulking agents in the process because it can drag a long time decompose and cause another pollution such as odour and water pollution.

2.9 Factor of composting process for food waste.

The parameters that affect the effectiveness of composting process in food waste include temperature, moisture content, pH level, aeration rate, C/N ratio, particle size and nutrient content [25]. The final product would significantly effect because of changes of these factors endlessly during decomposition process.

2.10 Moisture content in composting.

The physical and chemical properties of waste materials in course of degrading organic matter greatly affected moisture content. The moisture content is important for transferring the dissolve nutrients that are required for physiological and metabolic activities of microorganisms [24]. Iqbal in his study, most suitable moisture level for biodegradation of different compost mixture varies from 50% to 70% [25]. Low moisture level of feedstock during composting will stunted the growing of microbial during composting to develop the biochemical process occur during composting. Thus, suitable moisture content of food waste will allow microbial formation during composting and collapse of the composting component and to ensure the presence of oxygen during the process[26].

2.11 Particle size of feedstock for composting.

The size of feedstock used in composting can influence the composting process time and pile temperature. Previous study has been shown that the large size of particles have a smaller total surface area and have low approachable of microorganism rather than finer particles[27]. The finer compost will result in significant microbial activity and leads to have short composting time compared with coarse compost. It is because small particle has greater surface area that give more total volume exposed to decompose rather than large particles. Besides, the smaller size of feedstock will allow the microorganism to reach the particles quickly since it has more surface area that they can reach easily.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describe the materials, equipment and techniques involved in this experiment. The procedure involved in conducting the experiment and types of testing were also explained. In general, this experiment can be divided into two section, which comprised of:

a) First process: Grinding and dewatering process.
b) Second process: Moisture analysis and composting experiment.

3.2 Flowchart.

Figure below shows the flow chart that summarizes all of the procedures used in this project.

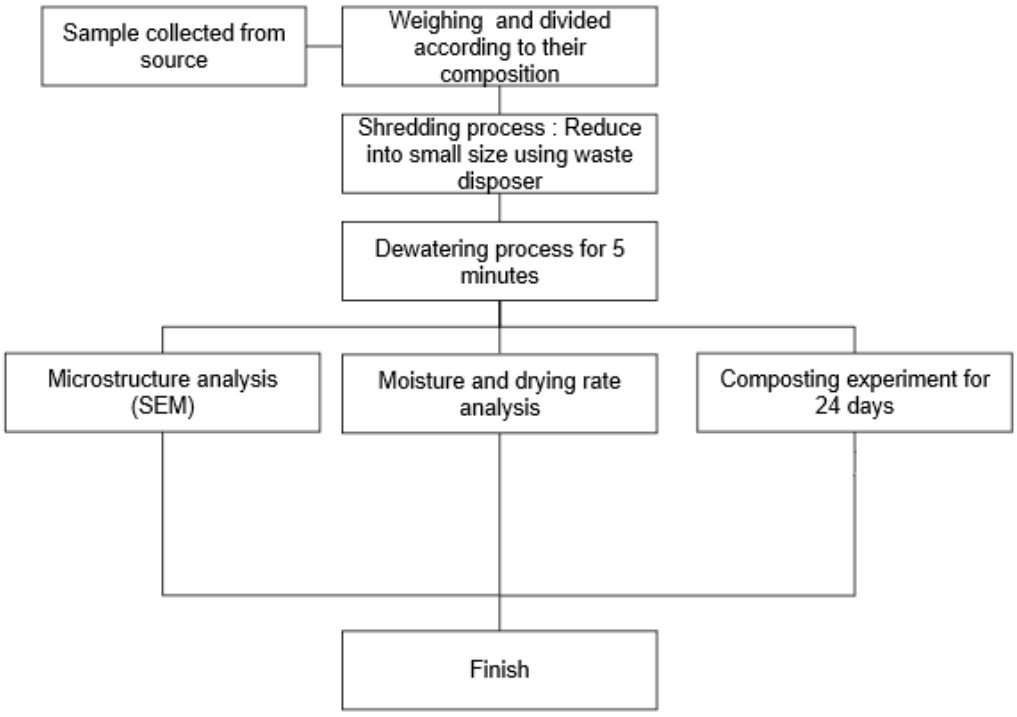


Figure 3.1: Flow chart for methodology.

3.3 Sample preparation.

In this experiment, the samples used are from kitchen waste which is consist of vegetable, fruits and kitchen mixed waste. This waste is collected from Lembaran Cafe USM and were kept in closed container under room temperature condition until processing. It also to prevent the microorganism growth in the waste and bad odor produced from it. The collected waste is taken one day before experiment run. The waste is separated according to their group such as vegetable, fruit , mixed waste. Each group of waste is separated again into single waste such as watermelon, honeydew, onion peel, green leaves and bones. Watermelon and honeydew peel are chosen because they contain higher moisture level and form of large size. The green leaves are taken as sample because it easily available in cafe and rich in fibre. The mixed kitchen waste consists of real municipal solid waste from kitchen and excessive food after eating. It contains fishbone, chicken bone, rice and mixed food waste which highly moisture level.

(a)

(b)

(c)

(d)

(e)

(f)

Figure 3.2: Raw waste (a) mixed kitchen waste, (b) onion peel, (c) green leaves waste (d) watermelon peel, (e) mixed vegetable peel and (f) honeydew peel.

3.4 Experiment apparatus and material

The dried waste is processed by using spin dryer (one Concept MNW3-WS-3500 Spin Dryer 6 kg 3200 R/min Stainless Steel White) were performed as dewatering mechanism. The overall height of the spin dryer 35 cm and diameter 65.5 cm. The weight of the dryer is approximately 11.1 kg. Since it builds with large stainless steel wash drum, it gives an advantage to the spin dryer which can withstand 6 kg capacity at one time and run high-speed rotation up to 2800 rev/min.

It utilizes centrifuge force pushes out the overflowing wastewater into a designated runoff which can easily be collected in a suitable container. In order to increase the

efficiency of dewatering process, the disposal waste (HSJ-03 Jiemei food waste disposer) is used to reduce the size of waste into the fine condition. It can effectively grind all kinds of food waste such as small bones, eggshell, fruit peels, vegetable scraps and other eating leftovers.

In moisture content analysis, it needs to dry the raw waste and dewatered waste in oven until it become equilibrium to ensure the bound water in waste removed and only left solid particle after drying process. It is to determine the water amount in waste before and after dewatering by measuring the different of wet weight and dry weight. The waste is dried in the oven for 72 hours at 105 °C and final weight is taken for moisture content calculation. For the drying rate analysis, the weight of waste is determined for every 60 minutes' interval for 9 hours.

For composting experiment, the apparatus used is digital thermometer and soil moisture meter device. The digital thermometer used to measure temperature of pile during aeration reaction. The moisture of pile can be determined using soil moisture meter device which measuring the electricity of compost material.

Figure 3.3: Weighing machine.

Figure 3.4: Oven.

Figure 3.5 Soil moisture meter.

Figure 3.6: Digital thermometer

Figure 3.7: Waste disposal.

Figure 3.8: Spin dryer.

Figure 3.9: Waste disposer with spin dryer.

3.5 Experiment procedure

3.5.1 Determination of weight loss after dewatering process.

1. The collected waste was divided based on their groups such like vegetable, fruit and mixed waste.
2. The group of waste is weighted to 1kg as initial weight before dewatering process.
3. The percentage of composition of waste in each group in 1kg is determined by weight it individually.
4. The filter bag was placed in spin dryer and tied at outlet pipe of waste disposal to allow the shredded waste trapped in the filter and avoid fine waste easily flow out through the spin dryer outlet.
5. The waste disposal was switched on and the waste was entered slowly into disposal with addition of water. The shredded waste is flow out through the outlet disposal to spin dryer.
6. After shredded process, the waste is dewatered using spin dryer for 5 minutes.
7. After 5 minutes, the final result of the waste was discharged from the spin dryer and the final weight was measured as weight after dewatering process

3.5.2 Determination of moisture analysis for kitchen waste.

1. The temperature of the oven was set to 105° C. The oven was left for about half an hour before it filled with sample to achieve the steady state condition.
2. The raw and dewatered sample was weight according to their percentage of composition and the total initial weight is 50 g.
3. The aluminum dishes filled with sample are placed in the oven for 72 hours.
4. The wastes were weight after left it dry until equilibrium for 72 hours and taken as final weight after drying at 72 hours.
5. Moisture content was calculated using formula:

$$Moisture\ content\ \% = \frac{Initial\ Wet\ Weight\ (g) - Final\ Dry\ Weight(g)}{Initial\ Wet\ Weight(g)} \text{ x } 100\%$$

6. The graph weight loss and drying rate versus drying time are plotted.

3.5.3 Determination of drying rate analysis for kitchen waste.

1. The temperature of the oven was set to 105° C. The oven was left for about half an hour before it filled with sample to achieve the steady state condition.
2. The raw and dewatered sample was weight according to their percentage of composition:

a) Mixed kitchen waste: 40 g
b) Vegetable waste: 40g
c) Fruit waste: 20 g

3. The aluminium dishes filled with sample are placed in the oven for 9 hours.
4. For measuring the weight of the sample during experimentation, the aluminum dishes with sample was taken out of oven, weighted on the weighing apparatus and placed back into the oven. The weight is taken each 60 minutes' interval in 9 hours.
5. The graph was plotted to observe the weight reduction within 9 hours in both raw and dewatered waste.

3.5.4 Microstructure analysis.

For the microstructure analysis, the fresh and dewatered waste were subjected to observation by Field Emission Scanning Electron Microscope (Hitachi FE-SEM S-3400N). The purpose of this analysis is to determine the condition of water bound and

changing of microstructure after dewatering in order to correlate with the microstructure findings.

Figure 3.10: Hitachi Scanning Electron Microstructure (SEM) machine.

3.5.5 Determination of composting effect by composting experiment.

1. Decompose material for composting was prepared. Below the composition of the decompose. The decompose was divided into 6 of pail which each of it have weight 2.6 kg. Each of the pail is labelled according to types of waste to be stored.
   Waste 1: Raw mixed kitchen waste
   Waste 2: Raw vegetable waste
   Waste 3: Raw fruit waste
   Waste 4: Dewatered mixed kitchen waste
   Waste 5: Dewatered vegetable
   Waste 6: Dewatered fruit waste
2. The sample was prepared

a) Fresh sample: consist of mixed kitchen waste, fruit waste and vegetable waste.

b) Dewatered waste: consist of mixed kitchen waste, fruit waste and vegetable waste.

1. All of wastes were weighted 50 g each as initial weight.
2. Then, the waste is planted into the decompose material according to their label at the pile.
3. The water is added to the soil as to maintain their moisture content up to 40% to 50%.
4. The temperature of soil is taken each 24 hours to ensure aeration reaction occurs during composting in 24 days.

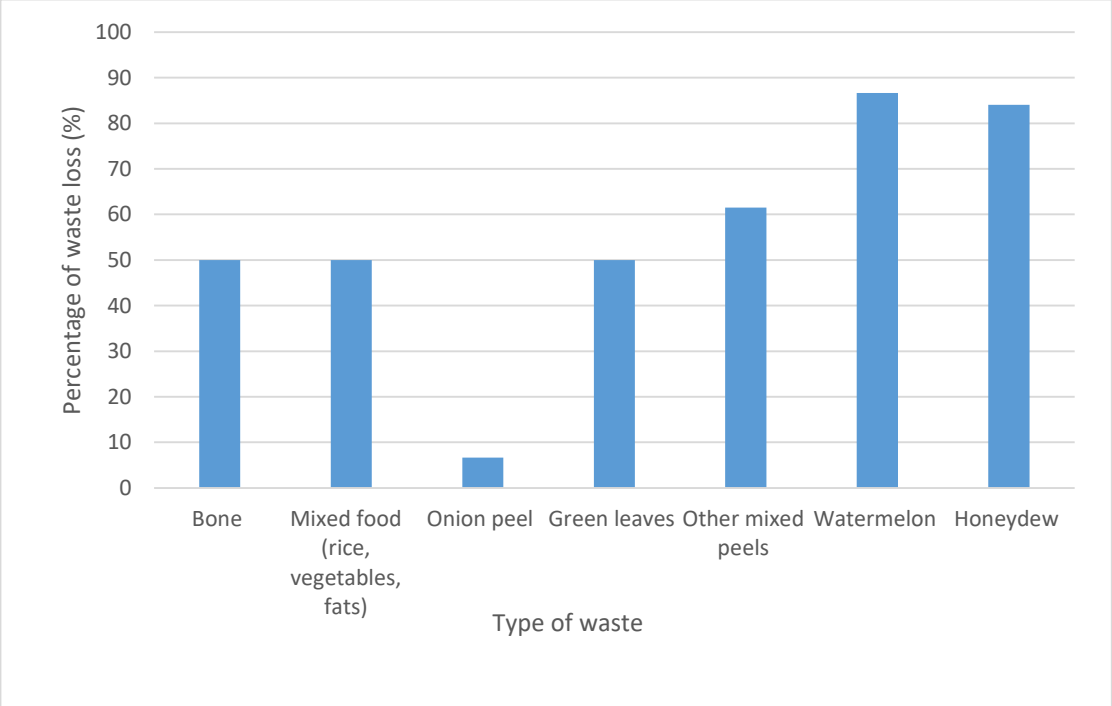
5. The condition of all wastes were identified at every 7 days to determine the microbial growth by observing and temperature taken during composting process.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Waste loss determination

4.1.1 Determination waste loss of different type of waste after dewatering process in 5 minutes**.**



Graph 4.1: Graph of waste loss of different type of waste after dewatering process in 5 minutes**.**