MINOR PROJECT REPORT
(MSCH6040)

on

FRUIT AND VEGETABLE WASTE CHARACTERIZATION

Submitted in Partial Fulfilment of the Requirement for the Degree of
M.Sc. Chemistry

Submitted by
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Enrollment No. 18032050007
M.Sc. Chemistry (III Semester)

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Division of Chemistry
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(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Basic and Applied Science

CERTIFICATE

This is to Certify that **Ms. Amisha Saxena** has carried out her minor project work entitled **"Fruit and vegetable waste characterization"** under my supervision. This work is fit for submission for the award of Master Degree in Chemistry.

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CERTIFICATE

This is to certify that **Ms. Amisha Saxena**, M.Sc. Chemistry from **School of Basic and Applied Sciences, Galgotias university, Greater Noida, Uttar Pradesh**, has worked under my guidance on project, entitled **"Fruit and vegetable waste characterization"** in chemistry lab.

I found her hard working and finished her project training within stipulated time frame.

I wish her a very good luck in her future endeavours.

Dr. Abid Ali Khan

CANDIDATE DECLARATION

I hereby declare that the dissertation entitled **“Fruit and vegetable waste characterization”** submitted by me in partial fulfillment for the degree of M.Sc. in Chemistry to the Division of Chemistry, School of Basic and Applied Science, Galgotias University, Greater Noida, Uttar Pradesh, India is my original work. It has not been submitted in part or full to this University of any other Universities for the award of diploma or degree.

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I deem it great pleasure to put forth my long conceived and well-nourished sense of gratitude to my friends, for their constant encouragement in all possible ways and their whole-hearted help rendered at the time of crisis would be remembered lifelong.

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AMISHA SAXENA

PROJECT SUMMARY

Fruit and vegetable waste characterization

This dissertation gives brief account on concept of waste characterization followed by the technique used for characterizing the waste. Further this thesis also throws light on some waste minimization by biogas plant technique. And to study the current practices related to the "**Azadpur Mandi**," market and the waste management taken in Delhi for human wellbeing. The other purpose is to provide some suggestions and recommendations to improve the waste management practices in Indian towns.in this project the main focus is on waste minimization as we know very well that waste management is becoming a serious global issue. In this report I work on Azadpur mandi and by performing various chemical test such as chemical oxygen demand, soluble chemical oxygen demand , pH and volatile fatty acids of various vegetables and fruits and also the total substrate and volatile content of various waste and by using activated sludge the co-digestion of market waste for enhanced biogas production and that produced biogas can we used in energy resources.

TABLE OF CONTENTS

ABBERVIATIONS

MSW: Municipal Solid Waste.

VFA: Volatile Fatty Acid.

FVW: Fruit and Vegetable Waste.

GHG: Green House Gases.

TS: Total Solid.

VS: Volatile Solid.

OP: Orange Peels.

COD: Chemical Oxygen Demand.

1. INTRODUCTION

1.1 what is waste:

“There are few things certain in life-one is death, second is change and the other is waste.” No one can stop these things to take place in our lives. But with better management we can prepare ourselves. Here we will talk about waste and waste management. Each of us has a right to clean air, water, and food. This right can be fulfilled by maintaining a clean and healthy environment. Now for the first question, what is waste? Any material which is not needed by the owner, producer or processor is waste. Generally, waste is defined as at the end of the product life cycle and is disposed of in landfills. Most businesses define waste as “anything that does not create value” in a common man’s eye anything that is unwanted or not useful is garbage or waste. However scientifically speaking there is no waste as such in the world. Fruits and vegetables wastes are generated in large quantities around Fruit and vegetable are distributed in high concentration in almost all regions of India. Fruit and vegetable production are fast growing export businesses, and India is a centre of diversity for a variety of fruit and vegetable plants so fruit and vegetable wastes are created during harvesting, transportation, storage, marketing and processing. Due to high biodegradability nature and high moisture content (75%-90%) wet fresh fruit and vegetable wastes seemed to be a good substrate for bio-energy recovery through anaerobic digestion process. Waste collected from residences, commercial buildings, institutions such as hospitals and schools, and light industrial operations is most often categorized as municipal solid waste. MSW consists primarily of paper, containers and packaging, food wastes, yard trimmings, and other inorganic wastes. Municipal solid waste can also include industrial sludge, classified as hazardous or non-hazardous, resulting from a wide array of mining, construction, and manufacturing processes.

1.2 What is organic waste:

Organic wastes contain materials which originated from living organisms. There are many types of organic wastes and they can be found in municipal solid waste , industrial solid waste , agricultural waste, and wastewaters. Organic wastes are often disposed of with other wastes in landfills or incinerators, but since they are biodegradable, some organic wastes are suitable for composting and land application. Organic materials found in municipal solid waste include food, paper, wood, sewage sludge, and yard waste. Because of recent shortages in landfill capacity, the number of municipal composting sites for yard wastes is increasing across the country, as is the number of citizens who compost yard wastes in their backyards. On a more limited basis, some mixed municipal waste composting is also taking place. Some treated industrial wastewaters and sludges contain large amounts of organic materials and they too can be used as soil fertilizers and amendments.

Production of biogas is another use of organic waste. Biogas is used as an alternative energy source in some third world countries. It is produced in digester units by the anaerobic decomposition of organic wastes such as manures and crop residues. Beneficial by products of biogas production include sludges that can be used to fertilize and improve soil, and the inactivation of pathogens in the waste.

Figure 1.2 organic waste.

1.3. Anaerobic Digestion:

Anaerobic digestion is a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen. One of the end products is biogas, which is combusted to generate electricity and heat, or can be processed into renewable natural gas and transportation fuels. A range of anaerobic digestion technologies are converting livestock manure, municipal wastewater solids, food waste, high strength industrial wastewater and residuals, fats, oils, and various other organic waste streams into biogas, 24 hours a day, 7 days a week. Separated digested solids can be composted, utilized for dairy bedding, directly applied to cropland or converted into other products. Nutrients in the liquid stream are used in agriculture as fertilizer.

A major limitation of anaerobic digestion of fruit and vegetable wastes are the rapid acidification due to the lower pH of wastes and the larger production of volatile fatty acids (VFA), which reduce the methanogenic activity of the reactor. The rate limiting step in fruit and vegetable wastes are methanogenesis rather than hydrolysis because methanogenic bacteria take long mass doubling time of 3-4 days in anaerobic reactors. However, fruit and vegetable wastes have high biodegradable nature and will be good feedstock materials for biogas digester. Hence it can be good feedstock materials for biogas production if it can be good feedstock materials for biogas production if it is mixed with some other biomass to enhance methanogenic activity. In addition, conversion FVW has long term benefits in reducing greenhouse gasses like carbon dioxide and methane, eliminates odour, produces a nutrient liquid for algal cultivation and plant irrigation and maximize recycling. It reduced imported fossil fuel and save money for the country, reduced GHG (CH_4 and CO_2) emission to the atmosphere and cheap environmentally sound waste recycling technologies. Whereas, research report and technologies related to biogas processing from fruit and vegetable waste is limited. Anaerobic systems are best optimized if the feed rate of organic material into the digester is as constant as possible.

This steady flow of organic material into the anaerobic digestion optimizes the conversion of the sugars in the waste material or feedstock into intermediate anaerobic products and helps keep the system functioning properly. The anaerobic digestion process is used in the treatment of domestic and industrial wastewater. Within the typical wastewater process, both primary (solid) and secondary (liquid) organic wastes can be anaerobically digested. Although that digestion process does produce methane, its primary intent is to reduce the volume of waste solids that must be disposed of. Increasingly, municipal plants are viewing methane as a beneficial by-product of solids processing, and they are capturing the methane to be used on-site. These wastes can be treated through biological process.[20].

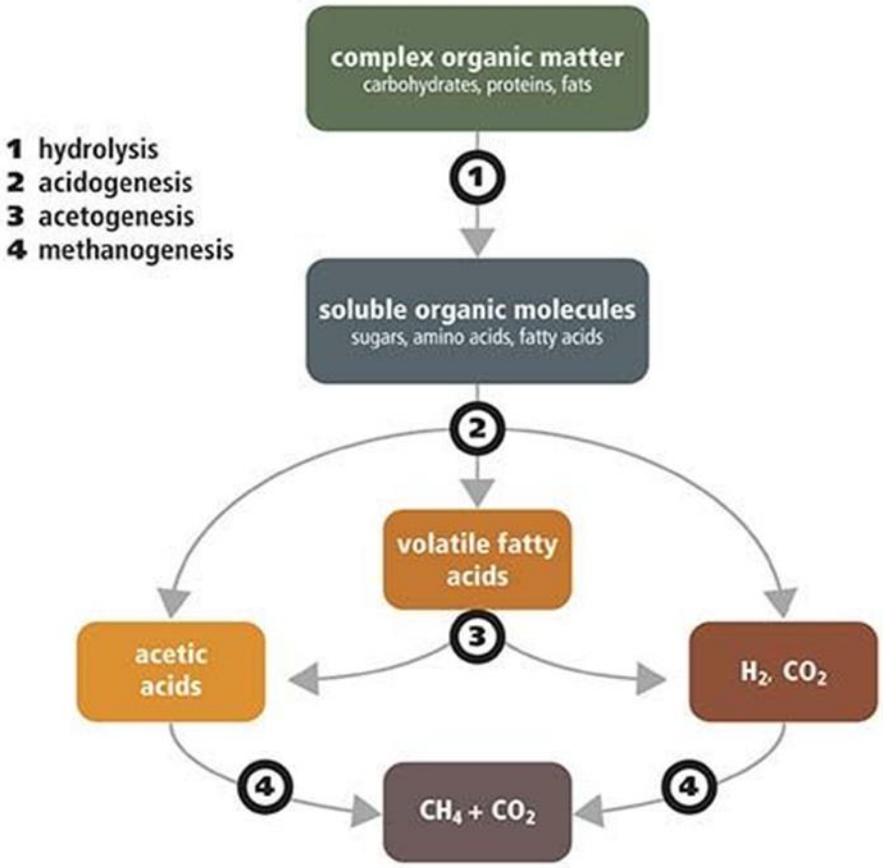


Figure 1.3 Anaerobic digestion of organic waste steps.

1.4 Activated Sludge:

The water consumed or used by humans in domestic & industrial fields generates inevitably wastes. Wastewaters are collected by drains and directed to wastewater treatment plants to be purified before come into the nature, activated sludge is the treatment process mainly used to achieve this objective. Wastewaters containing organic matter are aerated in which micro-organisms metabolize the suspended and soluble organic matter. In activated sludge systems the new products formed in the reaction are removed from the liquid stream in the form of sludge in settling tanks. A part of this settled biomass, described as activated sludge is returned to the aeration tank and the remaining forms waste or excess sludge. The activated sludge process has the advantage of producing a high-quality effluent for a reasonable operating and maintenance costs. The increase of the amount of sludge produced in municipal wastewater treatment plants has been recognized as a problem for several years, Management of activated sludge waste was the subject of various scientific researches. Biomethanisation is well known as the biological process to treat the sewage sludge by degrading organic matters, generating bio-energy and killing pathogens. This process was developed by several researchers. The conversion of organic matter to biogas occurs in a sequence of four steps: hydrolysis, acidogenesis, acetogenesis, and methanogenesis. Composting is one of the process recommended to manage activated sludge waste. Its principle is based on the production of organic fertilizer through the degradation of organic fraction of wastes. Composting is an aerobic process of converting fermentable organic matter by many microorganisms. It provides an oxidation of the organic material with water formation, carbon dioxide production and heat release.

Figure 1.4 Activated Sludge.

Chapter 2

LITERATURE REVIEW

2.1 Characterization of fruit and vegetable waste for energy production:

In 2004 production of five fruits and vegetables (cucumber, bell pepper, squash, tomato, watermelon) in Georgia amounted to 860 million pounds (390 million kg). The weight of fruit and vegetables listed above only accounts for that produce harvested and does not account for that produce remaining in the field after the market has eroded. This eroded market is associated with both the large producer working with major distributors or the small farmer growing mainly for local and regional farmers markets. From discussions with the environmental manager of one packing house, an estimate of the amount of fruits and vegetables that would be culled (thrown out) at the packing house would be 7%. This means that 60 million pounds (27 million kg) of fruit and vegetable waste would need to be discarded annually in Georgia.

Based on interviews of two watermelon farmers, an equal amount of unharvested watermelons remain in the field after harvest has occurred for sale. Collection of fruit and vegetable waste by the principal investigator indicates that 39,000 pounds of tomatoes and 49,000 pounds of watermelons are left on each acre (Hawkins, 2006) after harvest has been completed. This will change from year to year based on market and growing season, therefore collections will continue so that a average can be acquired. In 2004, Georgia had 6000 acres of tomatoes and 30,000 acres of watermelons planted. waste material from packing houses would be dumped in low lying areas on a farm, placed in landfills, incorporated into compost piles or fed to animals. Disposal of these waste products in low lying areas has the potential to pollute nearby waterways. Disposal in landfills costs the producer, fills the landfill space sooner and adds water to the landfill, potentially adding to leachate quantities. Composting of this material provides some conversion to materials that can be used as a soil amendment, but the waste product is typically greater than 85% moisture.[1] and has a high sugar content which aids in bacterial biomass growth, but little humus formation. Feeding to animals does dispose of the waste, but the potential transport cost could be a limiting factor to disposal. As this material decomposes in an environment void of oxygen, the predominate gas produced is methane and some carbon dioxide. According to Vieitez and Ghosh (1999), decomposition of each metric ton of solid waste could potentially release 50-110 m3 of carbon dioxide and 90-140 m3 of methane. The release of carbon dioxide can add to the increasing problem with greenhouse gasses, but methane is known to be 23 times worse as a greenhouse gas. Anaerobic systems are best optimized if the feed rate of organic material into the digester is as constant as possible. This steady flow of organic material into the anaerobic digestion optimizes the conversion of the sugars in the waste material or feedstock into intermediate anaerobic products and helps keep the system functioning properly. Therefore, the purpose of this research was to begin defining the physical and chemical characteristics of some of the fruits and vegetables grown in Georgia.

2.2 Characterization of fruit and vegetable waste as a single substrate for the anaerobic digestion:

Fruit and vegetable wastes (FVWs) represent a specific waste produced by all the markets and by many companies in the food industry. Due to their high handling and disposal are quite critical to community acceptance. Since they have very high moisture contents and biochemical processes, such as anaerobic digestion, are the most suitable conversion technologies to treat FVWs. To ensure process stability and good conversion efficiencies, it is of fundamental importance to accurately characterize the feedstock properties, especially physical and chemical characteristics like the Total Solid (TS), Volatile Solid (VS), Carbon, Nitrogen, macro, micro and trace elements contents. Moreover, on the basis of such parameters, a decision on whether using FVWs as a single feedstock or as co-substrate in the anaerobic digestion process can be made. Most of the studies on a complete residues' characterization focus on the organic fraction of the municipal solid waste [2], on biomass produced by the forestry, agriculture, municipality and industry sectors [3], or on food waste [4]. On the counterpart, to the authors' knowledge, most of the studies on fruit and vegetable wastes focus on their use as a co - substrate in the anaerobic digestion process [5]. This work presents a detailed characterization study of the chemical and physical properties of representative varieties of fruits and vegetables' residues produced by the Vegetable Wholesale Market of Sardinia (Italy). In addition, this study comments the feasibility of using FVWs as a single substrate in anaerobic digestion, on the basis of the existing scholarly literature and the results from the present analysis. More-over, the study estimates the expected biogas composition from the anaerobic digestion of FVWs.

2.3 Fruit peel waste: Characterization and its potential uses:

The agro-climate of India is very diverse, encouraging the cultivation of numerous crops, including fruit trees, vegetables, ornamental plants, root tubers, medicinal herbs, aromatic plants, spices, and plantation crops. India is the world’s second largest producer of fruits and vegetables. It is well-known that huge quantities of lignocellulosic biomass are produced every year during cultivation, harvesting, processing, and consumption of agricultural products. This biomass generated can be utilized for different applications such as a low-cost bio sorbent, and feedstock for producing biochemical and biofuels, and a substrate for production of various enzymes and metabolites. Besides, using these residues to produce value-added products will eliminate them from the environment and avoid solid-waste handling [6].

Orange contains orange peel (OP) which is an important by-product. OP comprises cellulose, hemicellulose, lignin, chlorophyll pigments, and other low-molecular weight compounds (e.g. limonene). Traditionally, OP is treated to obtain volatile and non-volatile fractions of essential oils and flavouring compounds. In addition, OP has been reported to have germicidal, antioxidant, and anticarcinogenic properties, and thus may be effective against breast and colon cancers, skin inflammation, muscle pain, stomach upset, and ringworm [7]. Lemon peel's outer layer is called flavedo, the colour which differs from green to yellow. Flavedo is a rich source of essential oils, that has been used since early times in flavouring and fragrance industries. The major component of lemon peel is albedo, which is a spongy and cellulosic layer under the flavedo and has high dietary fibre content [8]. These wastes have high potential for methane generation through anaerobic digestion but they are often landfilled.[9]. These waste can be treated through biological process referred to as which produces biogas.[10]. This poses greater threat to the health of the general public and the environment when they are disposed of at the landfill.[11]. Gases composition within storage and packaging and many more.[12]. Strategy and transformation Agriculture Intelligence, Core operation, Co-operate Services and Operational Support.[13]. Most of these wastes are organic wastes which include fruit and vegetable wastes.[14]. Some of these materials go bad easily since some might have had spots unnoticed from the farm and some might have experienced delay in shipment to the final consumer[15]. Chemical and thermal properties of waste components and to ensure that municipalities comply with both national and international regulations[16]. to evaluate the physical, chemical and thermal properties of waste components and to ensure that municipalities comply with both national and international regulations[18]. To determine the origin of different waste streams, to put up plans to acquire equipment that will process the waste streams[19].

CHAPTER 3

MATERIALS AND METHODOLOGIES

3.1 Feedstock (Inputs):

The substrate used as feed stock materials for the generation of biogas in the laboratory were samples of fruit, vegetable and activated sludge in same proportions. The fruit and vegetable waste (FVW) were collected from fruit and vegetable market (Azadpur mandi, Delhi). The vegetable and fruit feedstock materials were shredded manually into small pieces and it grounds to use for digestion(physical pre-treatment, particle size reduction) and after shredding to small size and make relative very small size for the mixing and homogeneity in the digester, the raw FVW was used as a feed to the reactor and kept at normal temperature until use.

Figure 3.1 Collection of market waste.

Figure 3.2 Azadpur Mandi waste.

3.2 Physico-Chemical Properties of the feedstock:

3.2.1 Total Solids:

Total dry solids (TS) are the solid substance presented in the sample which contains both organic and inorganic matter. Freshly collected samples of each of 5 ml of activated sludge, and FVW was weighed using electrical balance, and placed inside an electric hot air-oven maintained at 105°C using a crucible and stayed in the oven for 24 hours and then taken out, cooled in a desiccator and weighed. The percentage of this total solid was calculated according to the Equation 1.

$$\%T.S.=MDS \div MFS \times 100\% \quad \text{Equation 1.}$$

Where, %TS: Percentage of total solid

MDS: Mass of dry sample

MFS: Mass of fresh sample.

3.2.2 Volatile Solids:

Determinations of fixed and volatile solids do not distinguish precisely between inorganic and organic matter because the loss on ignite is not confined to organic matter. It includes losses due to decomposition or volatilization of some mineral salts. The TS obtained was ignited at 550 °C in a muffle furnace for five hours to determine the volatile and fixed solid content of the sample and to calculate the percentage of volatile solid content using Equation 2.

$$\% \text{ V.S.} = \text{MDS} - \text{M(ASH)} \div \text{MDS} \times 100\% \quad \text{Equation 2}$$

Where %VS: percentage of volatile solid

MDS: Mass of dry Sample

M (ASH): the remaining mass after ignition which is called fixed solid (the total solid that composed volatile and fixed slides)

3.2.3. Fixed solids:

The TS obtained was Ignited at 550 °C in a muffle furnace for 5 hours to determine the fixed solid content of the sample and to calculate the percentage of volatile solid content of the TS and by Cooling the residue in a desiccators to balance the temperature and to weighting the residues and repeat igniting (30 min), cooling, desiccating and weighing steps until the weight change is less than 4% or 50 mg, whichever is less and record the final weight . It was calculated according to the Equation 3 or Equation 4.

$$\% \text{ Fixed Solid} = W_{volatile} - W_{dish} / \text{Wtotal} \times 100\% \quad \text{Equation 3}$$

Where; Wdish: Weight of dish (mg)

Wtotal: weight of dried residue and dish (mg)

volatile: weight of residue and dish after ignition (mg)

3.2.4. Fixed Carbon:

Fixed carbon is the solid combustible residue that remains after a coal particle is heated and the volatile matter is expelled.

3.2.5. Moisture content:

The moisture content of dried fruits and vegetables was found using a laboratory drying oven. Finely chopped samples were carefully dried in a laboratory oven at 105oC +/-1 C for 24 hours and reweighed. They were put back into the oven and checked again at hourly intervals until they longer lose any weight. The moisture content was calculated using the Equation 4.

$$\% \text{ Moisture} = \text{initial weight} - \text{final weight} / \text{initial weight} \times 100\% \quad \text{Equation 5}$$

3.2.6 Chemical Oxygen Demand:

Chemical Oxygen Demand (COD) analysis is a measurement of the oxygen-depletion capacity of a water sample contaminated with organic waste matter. Specifically, it measures the equivalent amount of oxygen required to chemically oxidize organic compounds in water. COD values for the samples were measured using the COD Test-N-Tube method (HACH Company, Loveland, CO) and are a measure of the amount of oxygen required to completely convert any organic compound into carbon dioxide and water. The COD measurement is also a means to characterize the strength of the liquid, in this case the tomato The VS and COD values are directly used in determining the amount of material that can be fed into an anaerobic digester on a daily basis.

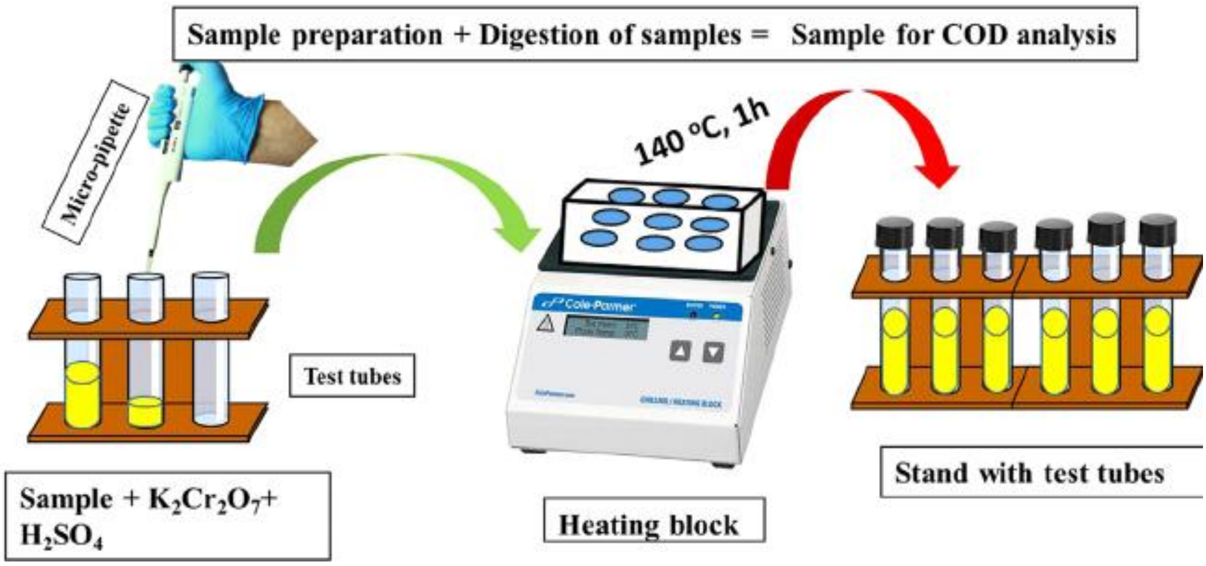


Figure 3.2.6 Schematic experimental diagram for determination of chemical oxygen demand.

3.2.7. Biogas Yield:

The volume and methane content of the gas produced in the anaerobic reactors were measured by an indirect method and determination of the composition of biogas gas was done by gas chromatography analysis. The indirect method was employed to estimate both the amount of biogas produced and the methane content of the gas. First, the volume of water is displaced by the gas was measured by down ward displacement of water for each digester which corresponds to the amount of biogas produced. Subsequently, the methane content in the biogas was estimated corresponding to the amount of CO_2 and Characterization of Fruit and Vegetable Wastes for Biogas Production under Anaerobic Condition 4 produced from the digesters. The gas was allowed to pass through a 10% NaOH solution as the CO2 dissolves in it and form carbonate. Thus, the amount of NaOH displaced is approximately equal to the amount of methane in the gas. Other types of gases. The waste samples were classified based on the colour of the FVWs[17].

Figure 3.2.7 Biogas production plant in lab.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Characterization of Feed Stock:

The total solid and volatile solid of both fruit and vegetable waste and activated sludge was determined with three replications and their average values are presented in table 1. As it was summarized in the table, the total solid content of fruit and vegetable waste for TSVS and ash content of the substrate were given values in table respectively. this showed that large fraction of fruit and vegetable is biodegrable and thus it can serve as an important feedstock material for biogas production. The methane yield and its production rates are highly influenced by the balance of carbon and nitrogen in the feeding material. The nitrogen content of FVW which is by far higher than the expected value as most fruit. This shows that FVW could serve as a substrate for biogas production even without mixing it with cow dung or other animal and human waste provided that it is available in the area. For the mixture treatments of these substrates, Thus, in both substrates the balance of carbon and nitrogen is good for the bacteria so that both could be used for anaerobic digestion for biogas production.

Sample	COD (mg/L)	TS (%)	VS (%)	Moisture Content(%)	Fixed Carbon (%)	Ash Content (%)	pH
Corn	123320	10	60	30	15.88	4.12	5.4
Garlic	162080	20	34	30.33	5	0.75	3.2
Pineapple	105040	30	50	11.21	29.043	7.427	7.1
Jackfruit	260540	12.6	3.12	10	19.54	0.46	5.8
Lemon	41060	7	3.2	6.1	3.59	5.31	4.9
Mosambi	247140	30	51	30	12.8	6.2	2.7
Banana Peels	39140	11.21	52.32	20	35.46	10.54	7.4
Radish Leaves	20180	94.71	51	87.4	0.94	8.54	3.5
Cabbage	40040	6.1	85	93	2.8	1	6.5
Total Mix	320700	30.33	63.91	35.34	13.2253	8.0847	7.2

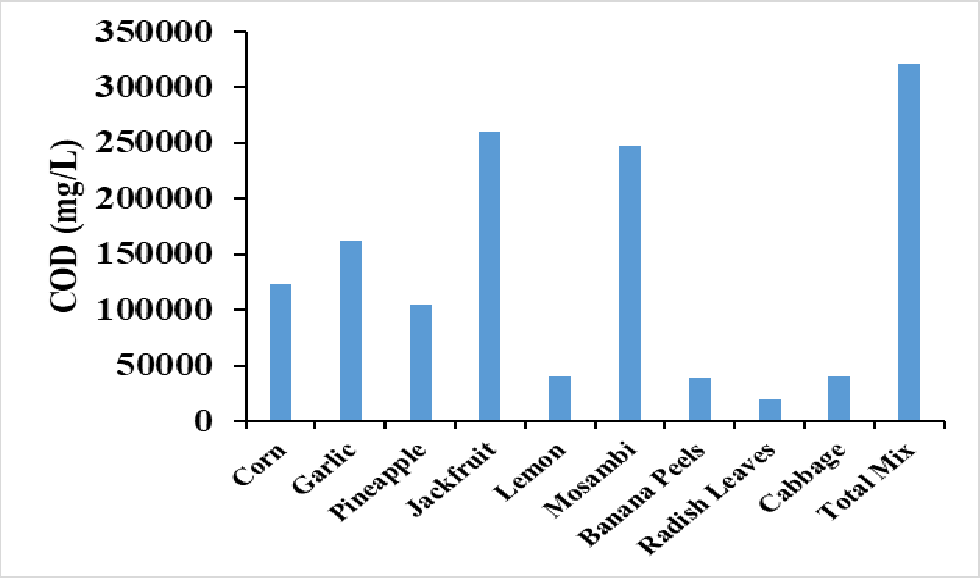
Table 1: Fruit and Vegetable characterization of feedstock.

4.2 Temperature:

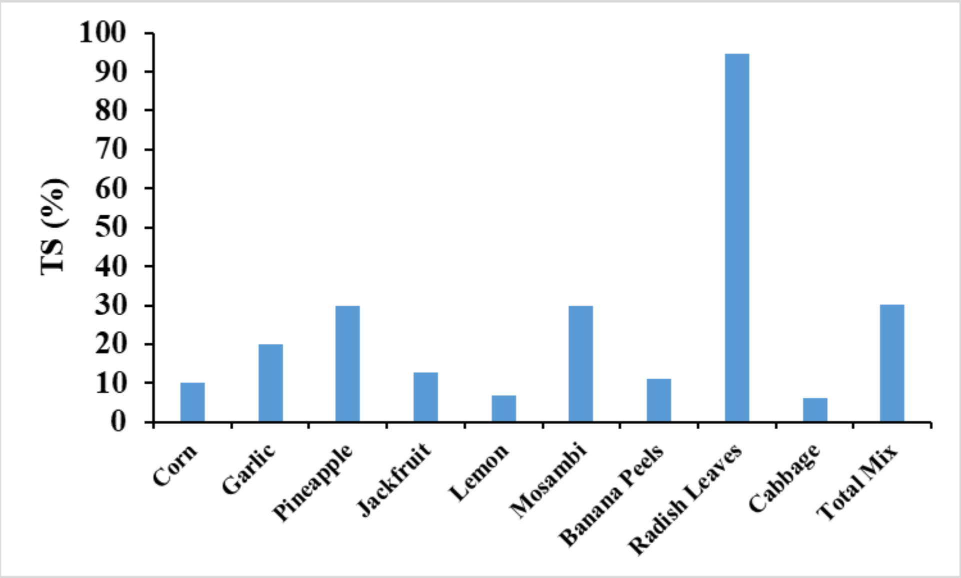
Reasonable methane yields still can be expected from anaerobic digestion at high temperatures (25-45°C) if the organic loading of the digester is reduced by means of extending the hydraulic retention. Both the mean temperature and the temperature fluctuations adversely affect the performance of a biogas digester. The day time temperature of the room where digestion took place was measured three times a day It was found that the minimum and maximum day time temperatures were 25°C and 35°C, respectively. The mean daily temperature of the digestion room during the digestion period was 35- 42°C. This means that there was a maximum fluctuation for 1 month of 2 to 4°C. This fluctuation was minimized by thick covering of the digesters with sand which brought the digesters' temperature fluctuation to less than 2°C. Practically, In this experiment it can be deduced that it is possible to produce biogas in such temperature range (34-44°C).

4.3 pH:

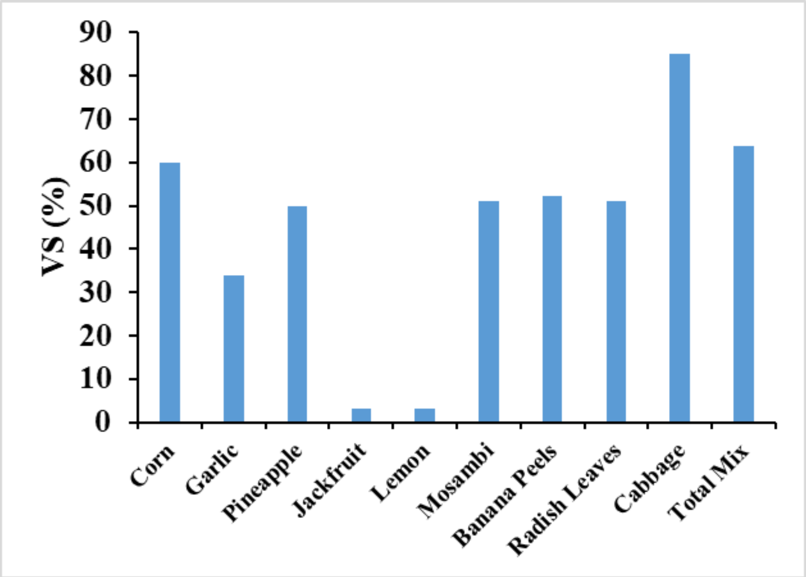
pH is another factor that affects digestion of substrates in reactors. Thus, the pH of all the treatments was measured in three days interval regularly. The initial pH of each input mixture of treatments, T1, T2, T3, T4, and T5, respectively. This is not in agreement with a pH range of 6.5 to 7.5 which is conductive for methanogenic bacteria to function properly as indicated. These initial values changed throughout the digestion period that is initial acidic condition and at the end of the digestion period was also acidic.



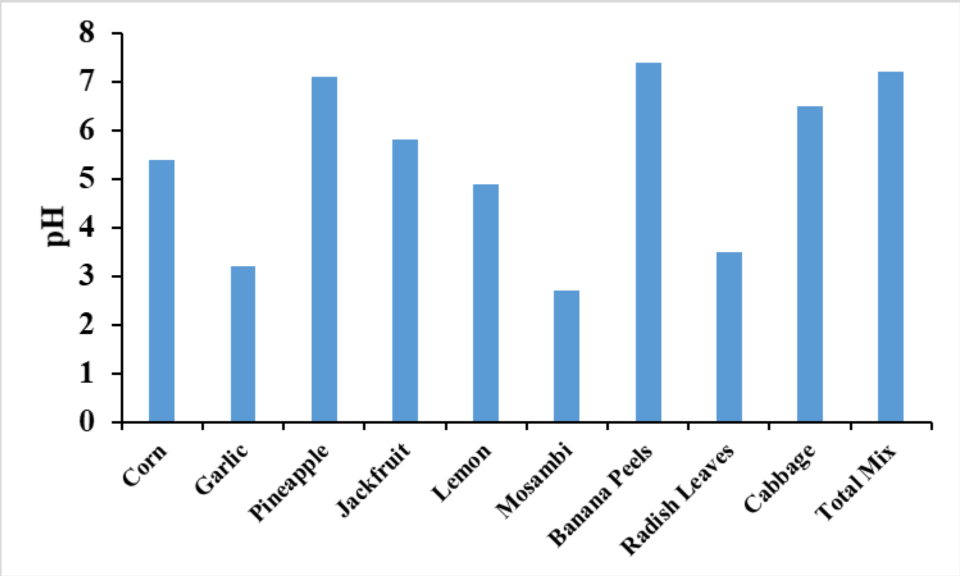
Graph 1:Comparison of COD consumption.



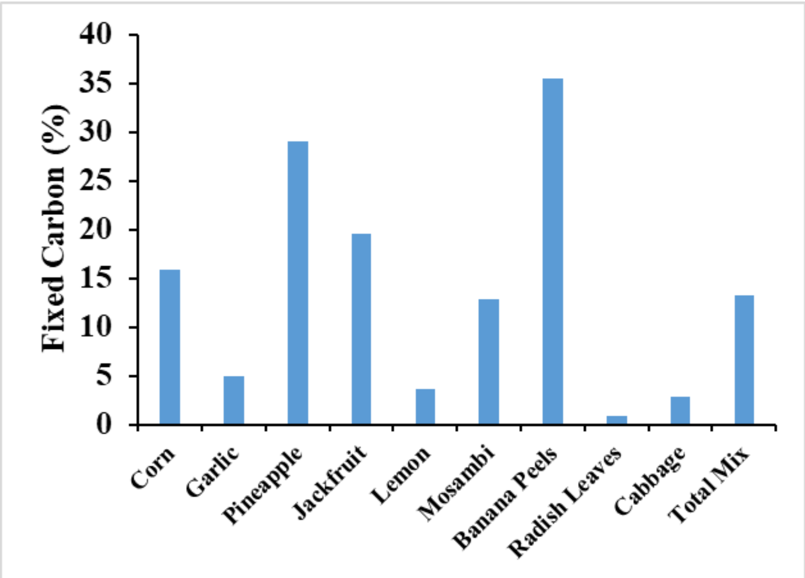
Graph 2:Comparison of Total solid.



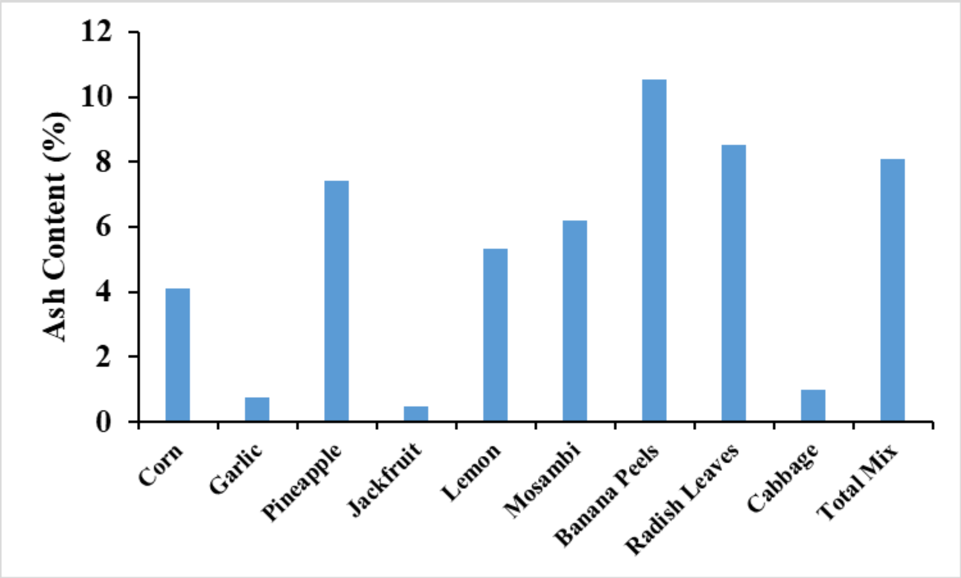
Graph 3:Comparison of Volatile solids



Graph 4: Comparison of pH



Graph 5: Comparison of Fixed Carbon



Graph 6: Comparison of Ash Content.

5.CONCLUSION

Determining the values for the physical and chemical characteristics of fruit and vegetable waste is the initial process in designing an anaerobic digestion system for the conversion of fruit and vegetable waste to energy. As can been seen from the data presented here, the VS contents of two of the three fruits and vegetables are significantly the same which means when designing an anaerobic digestion system based on VS we can load or feed the digesters at the same rate A feed rate half that of the other two would be required. If however, we only concentrate on the liquid fraction as a feedstock for the anaerobic digestion system, Overall, when designing an anaerobic digestion system, the characteristics of the feedstock is important in that the microbial population in the digesters can only decompose and convert sugars, carbohydrates and proteins into methane at a given rate. Analysing the physical and chemical characteristics of fruit and vegetable waste allows the anaerobic digestion manager to best optimize the feed rate of waste into the digesters and. The results of the characterization presented in this study demonstrate that FVWs are an eligible single feedstock for anaerobic digestion. Indeed, they have optimal moisture and Volatile Solid contents and, in accordance with their chemical composition, the maximum expected methane concentration in the biogas produced is 70 %. Proper mixtures of fruits and vegetables allow having a feedstock with balanced properties in terms of macro, micro and trace elements that prevent the instability of the anaerobic digestion process. The practice of adding external sources of nutrients can be avoided, generating cost savings for the anaerobic digestion plants therefore optimize the output of methane. It was observed that about 130 tons of FVWs are disposed of at the landfill site from the Azadpur mandi on daily basis. This is not healthy to the economy of the nation since resources can be recouped from these wastes either through converting it to fuel or generating electricity from it. Disposing the organic fraction of MSW to the landfills lead to the emission of CO_2 which is the primary source of greenhouse gases (GHG) which ultimately contributes to global warming and this poses threat to the health of the general public and it also impacts the environment negatively.

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