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Short Communication

Physico-chemical characterization of vegetable wastes for its proper management

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Abstract

Vegetable waste is a type of agricultural wastes. Daily huge quantity of vegetable wastes is produced in market. They are easily decomposed and are voluminous. The management of these wastes from disposal point of view is indeed important. Vegetable wastes have high pollution potential as far as environmental health is concerned. Unscientific disposal methods cause heavy damage to every component of environment. Biomethanation and vermicomposting are the two economical biological treatment methods. Biomethanation is however more economical than vermin-composting, since it generates energy in the form of biogas and effluent generated have manural value whereas vermi-composting generates only manure. The objective of the current study was to analyse physico-chemical characteristics of vegetable waste and in turn its amenability as a substrate for biogas production through biomethanation process. The vegetable waste was found to be slightly acidic with high percentage of organic material, macro and microelements. The results showed the selected vegetable waste mixture have potential as a substrate to produce biogas after its pretreatment.

Keywords: Vegetable waste, environmental pollution, physico-chemical characteristics, etc.

Introduction

The vegetables are the most important components of balanced diet for maintenance of good health and preventing the diseases. They supply energy giving carbohydrates, health giving vitamins and bone forming minerals with excellent fibre content required to maintain health of digestive tract. The India is second to China in production of vegetables and account for 15% of world's vegetable market. The large production of vegetables in India is owing to suitable climate and soil profile. In the different regions of India, root and leafy vegetables of different type of vegetables are found. As compared to global scenario, the order of production of vegetables in India is cauliflower, followed by brinjal, onion, cabbage, green peas, potato and tomato. It is found from statistical record that the area and production of vegetables is increasing as represented in Figure-1.

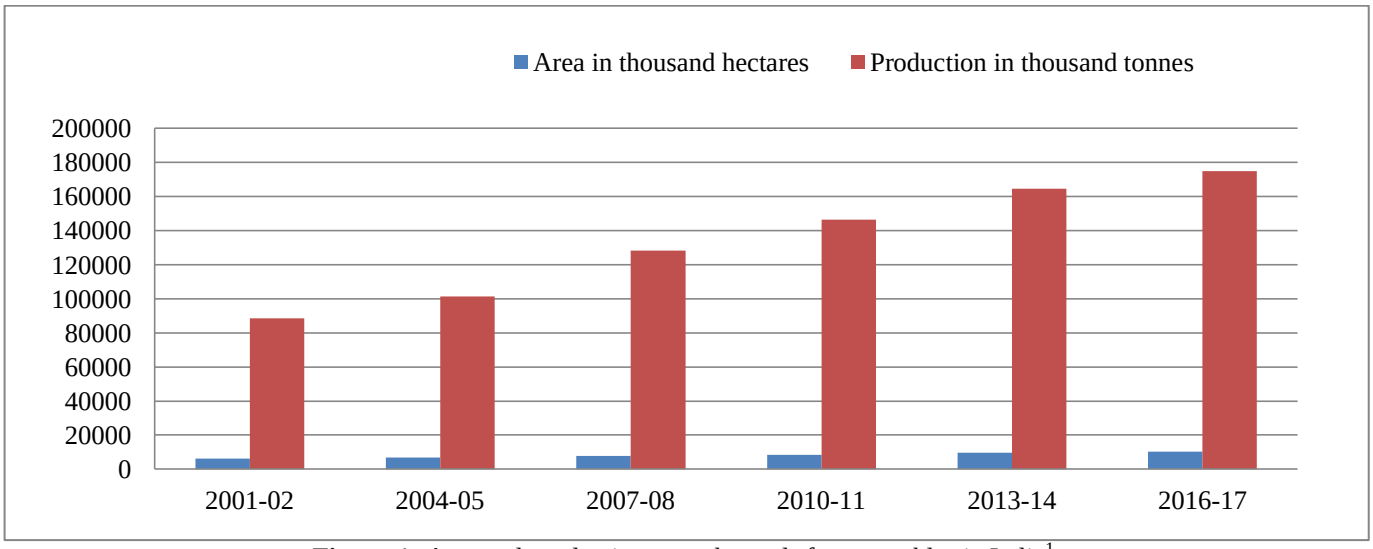

Figure-1: Area and production growth trends for vegetables in India[1].

India being one of the largest vegetables producers, plenty of vegetable waste is also produced in vegetable markets, in the municipal corporations, municipalities and villages in India. The considerable amount of vegetable waste is also generated in kitchens, hotels and restaurants. Out of 320 million tonnes of agricultural wastes generated in India anuualy[2], the bulk is constituted by vegetable waste. The vegetable waste contains high moisture and nutrient content owing to which they are highly biodegradable and unless disposed immediately, creates filty conditions due to rotting. Presently, vegetable wastes are disposed by landfills prepared by municipal corporations or spread in open land followed by sun drying and upto certain extent feeding to animals. But inadequate and unscientific methods if followed cause adverse conditions at the site and influences environment and health and get deprived of valuable commodities like fuel, fodder and fertilizers out of waste[3,4]. The leachate produced in the landfills may promote the growth of insects like mosquitoes and flies, rodents and other vectors of various diseases[5,6] and produce undesirable odours, and greenhouse gases which contribute to global warming. Hence, it's a need of time to use appropriate technology for disposal of vegetable waste.

Biomethanation and vermicomposting are the two economical biological treatment methods. Biomethanation is however more economical than vermin-composting, since it generates biogas and liquid portion called effluent have manural value whereas vermi-composting generates only manure[7-9]. Biomethanation further cause reduction in environmental pollution. The information on the nature of wastes and its physical and chemical characteristics are basic needs for the planning of waste management. The chemical composition of waste helps to decide proper management method since improper disposal results into serious environmental pollution.

Several researchers have carried out physico-chemical characterization of solid wastes from municipalities, agricultural residues, industrial remnants and food waste[10-13]. Arya and Katariya[14] studied and evaluated physic-chemical nature of waste based manure and proposed solid waste can be converted into compost which is called as organic fertilizer and have great demand in agriculture field. Asquer et al[15] carried out physic-chemical analysis of residues consisting of fruits and vegetables for its biomethanation potential from Sardinia market, Italy. Das et al[16] studied the composition of fresh vegetable waste from different sources to determine its feed value for cattles. Sharoba et al[17] performed analysis of heterogeneous mixture of fruits and vegetables waste. Nagy et al[18] carried out physico-chemical analysis of different types of canteen food substance and suggested its suitability for synthesis gas production. Singh et al[19] studied chemical analysis of vegetable wastes for determining its potential to produce various biofuels. The present work was undertaken to analyse physico-chemical characteristics of vegetable waste mixture of dominant vegetable types. The study will help to decide amenability of selected vegetable waste mixture for biomethanation.

Materials and methods

Collection and processing of sample: Wet vegetable wastes collected from different vegetable markets in Satara city were separated as individuals and equal quantity of these was processed to prepare paste using grinder. Storage was done at refridgeration temperature.

Physico-chemical characterization of vegetable waste: The analysis of vegetable waste mixture was done by standard methods[20]. Chemicals and methodology used were as per standard methods[20,21]. The parameters and analysis methods are given the Table-1.

Table-1: Methods used for chemical analysis of vegetable waste.

Parameter	Method used
Colour	Visual
Odour	Smelling
pH	Potentiometric
Temperature	Thermometric
Total Solids (TS)	Gravimetric
Total Volatile Solids (TVS)	Gravimetric
Total dissolved solids (TDS)	Gravimetric
Total suspended solids (TSS)	Gravimetric
Organic matter	Walkley and Black
Total organic Carbon	Walkley and Black
Total Kjeldahl Nitrogen (TKN)	Kjeldahl distillation
Phosphorus	Stannous Chloride (Spectrophotometric)
Potassium	Flame photometric
Sodium	Flame photometric
Sulphates	Spectrophotometric
Sulfides	Spectrophotometric
BOD_5 (20^0C for 5 days)	Azide modification
COD	Dichromate reflux & Titrimetric
Total volatile fatty acids (as CH_3COOH)	Titrimetric
Starch	Acid Digestion & Titrimetric
Cellulose	Acid- alkali Digestion & Titrimetric
Hemicellulose	Acid- alkali Digestion & Titrimetric
Lignin	Acid- alkali Digestion & Titrimetric
Total protein (%)	Kjeldahl
Total fats	Soxhlet Extraction
Crude fibres	Gravimetric

Results and discussion

Physico-chemical analysis of vegetable waste: Potato, Onion, Cabbage, Cauliflower, Tomato and Brinjal wastes were present in majority in collected wet vegetable wastes (Table-2). The equal proportions of these six individual wastes were mixed, shredded and ground to prepare paste (Figure-2). The analysis results of vegetable waste mixture have represented in Table-3.

Table-2: Components of vegetable waste mixture

Common name	Botanical name	Plant part used
Potato	*Solanumtuberosum* L.	Tuber
Onion	*Allium cepa* L.	Bulb(stem)
Tomato	*Lycopersiconesculentum* Mill.	Fruit
Brinjal	*Solanummelongena* L.	Fruit
Cauliflower	*Brassica oleraceae* L. var. botrytis	Head and stalk
Cabbage	*Brassica oleracea* L. var. capitata	Head

Figure-2: Slurry of mixed vegetable waste.

The vegetable waste mixture composed of equal fractions of six dominating vegetable waste types was yellow and had foul odour. The chemical characterization showed that it was slightly neutral with pH 6.7. The moisture content was 89.5%. The waste was rich in organic matter which was reflected by its high BOD, COD, TOC and TVS values. The BOD and COD of waste were 97150mg/L and 174000mg/L respectively. The total solid concentration was 44300mg/kg with the major content as total volatile solids (38300mg/kg) which accounts for 86.5% of total solids. Different types of carbohydrates, fat and proteins were present in significant quantities.

Table-3: Physico-chemical analysis of vegetable waste:

Parameter	Value
Colour	Yellowish
Odour	Foul
pH	6.70
Temperature (^{o}C)	29
Total solids (mg/kg)	44300
Total volatile solids (mg/kg)	38300
Total dissolved solids (mg/kg)	5160
Total suspended solids (mg/kg)	39140
Organic matter (mg/kg)	38400
Total organic carbon (mg/kg)	22260
Starch (mg/kg)	9900
Cellulose(mg/kg)	8700
Hemicellulose (mg/kg)	2400
Lignin (mg/kg)	2200
Total protein (mg/kg)	9081
Total fats (mg/kg)	4000
Crude fibres (mg/kg)	3000
BOD 5 days at 20^{0}C (mg/l)	97150
COD(mg/l)	174000
Total nitrogen (mg/kg)	1453
Phosphorus(mg/kg)	101
Potassium (mg/kg)	538
Sodium (mg/kg)	65
Sulphates (mg/kg)	580
Sulfides (mg/kg)	6.8
Total volatile fatty acids (as CH_3COOH) (%)	578

The chemical analysis of the vegetable waste revealed that the waste contained significant amounts of organic matter which was reflected by high BOD, COD, TOC and TVS values. The BOD and COD of vegetable waste slurry were 97150mg/L and 174000mg/L respectively. The total solid content was 44300 mg/kg with the major content as total volatile solids which accounts for 86.5% of total solid content. The waste contained high amount of carbohydrates with high percentage of biodegradable carbohydrate residues. The waste contains significant amounts of protein and fats. The micronutrients nutrients in the form of Nitrogen, phosphorus, potassium, and micronutrients were also present in significant quantities.

The total organic carbon to total nitrogen ratio was 15.38. The BOD: N: P ratio was 962:14:1. The Phosphorus and potassium content was 101mg/kg and 538mg/kg respectively. The sodium, sulphates and sulphide content of the waste was 65mg/kg, 580 mg/kg and 6.8 mg/kg respectively. The quantity of total volatile fatty acid of the waste slurry was 578mg/kg. The ratio of total organic carbon to total nitrogen was found to be 15.38 indicating slight nitrogen deficiencies[22]. BOD: N: P ratio was 962:14:1 which indicated that the ratio essential for biomethanation is higher than the expected ratio. C: N and BOD: N: P ratios generally considered critical for biomethanation should be in the range of 20-30 and 120:5:1, respectively[23]. The macroelements like nitrogen, phosphorus, potassium and sodium content were significantly higher.

There are reports of an efficient digestion of heterogenous mixture of vegetable market waste for biogas generation by various researchers[24-28]. The present vegetable waste mixture being rich in easily biodegradable carbohydrates, moisture content, macronutrients and micronutrients can be used for energy generation by biomethanation process after its pretreatment to neutralize its acidity and biogas yield may be higher than reported for heterogeneous mixture of vegetable wastes.

Conclusion

The present study revealed the physico-chemical characterization of vegetable waste mixture composed of equal mixture of six vegetable waste types. The pH level of vegetable waste slurry was slightly acidic, which unless neutralized, was found to be unsuitable for biomethanation. Higher BOD and COD levels 97150mg/l and 174000mg/l respectively showed the appropriateness of the waste to act, in general, as good substrate for biomethanation. C: N ratio was fairly suitable for biomethanation. TVS were fairly high at 86.5% of total solids content of vegetable waste, indicating general suitability for biomethanation. The concentrations of macronutrients and micronutrients were significant. The present study suggests that the present vegetable waste mixture after its pretreatment can serve as highly amenable substrate for biogas production through biomethanation process.

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