

Utilization of Bioslurry from Biogas Plant as Fertilizer



J.Devarenjan,G.M.Joselin Herbert, D.Amutha

Abstract:The conventional sources of energy are polluting the environment and getting depleted. The only option is renewable sources of energy like biogas. Disposal of large amount of bio gas slurry (BGS) produced is a major concern. Recycling of organic waste such as cattle dung, vegetable waste, food waste by the process of anaerobic digestion in the biogas plant (BGP) will be a great potential than producing any other fossil fuels. In many of the developing countries like India, cattle dung, crops residues will be produced in very large amount and hence it possible for producing bio gas and the bio slurry as the by-product. Hence, utilization of bio slurry as a fertilizer is an effective way. It increases the productivity of the soil. It is cheap and easily available fertilizer for the small scale farmers who could not afford in buying synthetic fertilizers. Bio slurry is nowadays being used as an effective source of fertilizer. It has high nitrogen (N), phosphorous (P) and potassium (K) that are considered to be the macro nutrients required for the flourishing growth of plants. It also contains some micro nutrients. It reduces the cost of natural organic fertilizer and increases the fertility of the soil.

Keywords: Bio slurry, Fertilizer, Macro nutrients and cost.

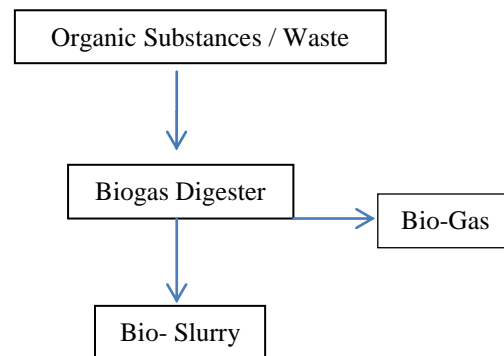
I. INTRODUCTION

Energy is one of the essential requirements for the development of any nation [1].Biomass is the one of the renewable fuel which in turns reduces the usage of the fossil fuel [2]. The production of biomass will reduce environmental pollution [3]. In India biogas plants have been installed as a result of ‘Biogas Support Program’ in rural areas of Nepal and more than a lakh plants were established. In Vietnam, Biogas Program for Animal Husbandry Sector has established more than 20,000 plants [4].

Bio fuels can be used for a long time as an environmental friendly and can be also used for transportation fuel [5].Usage of biofuel in homes and in vehicles reduces fossil fuel consumption [2]. When compared with other fertilizer, the nutrients which are present in the slurry will be readily available and it has a larger fertilization [6]. Improvements in agriculture led to the development of organic farming. The byproduct obtained from the BGP is called as slurry with contains lots of nutrients which are required for the flourishing growth of plants.Spent slurry obtained as the remains in a BGP is a most ideal source of organic agriculture. It contains appreciable quantities of both micro-nutrients and also macro-nutrients when compared to other sources of organic nutrients [7]. Bio slurry acts as an organic fertilizer [8]. When the biomass is processed, it can be transformed into solid, liquid and gaseous state [9].This paper reviews production of biogas and bio slurry, organic farming using slurry and compositions and characteristics of bio slurry. Bioslurry obtained from BGP is utilized as a good organic fertilizer.

II. PRODUCTION OF BIOGAS AND BIO SLURRY

Among the different types of renewable energy, energy derived from biomass (i.e.) remains of plants, animals and other biological organisms is considered as green and hence lowers the pollution by utilizing them[9]. The by-products obtained by the metabolic reactions taking place are called as bioenergy [2].



Almost all bacteria except archebacteria require oxygen for their growth. Bacteria grow more rapidly when there is presence of oxygen. When there is a deficiency of free oxygen inside the plant they survive by utilizing various other elements present in the plant. This leads to the production of methane gas as a waste product [10].

Manuscript published on November 30, 2019.

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One such type of bioenergy is biogas. Literature survey made by experts show only 200 kilocalories is converted into biogas from one kilogram of dry dung. But the same amount of dung produces 4000 kilocalories if burnt. In a BGP if the materials such as sugar, starch, proteins, cellulose and fats are present for about one kilogram, they provide 800 liters of biogas in the sense they are totally digested and no slurry is left behind. If ten kilogram of leaves is put into the biogas plant, it yields only a kilogram of biogas because green leaves contains 80% water, 10% of lignin and only 10% of digestible matter. The bacteria present inside the biogas plant decomposes only the mucus content present in dung, and the remaining about 90% is settled as slurry. Hence, for producing a kilogram of biogas needs around 40 kilograms of dung [11]. Some of the specific crops are used as raw materials to produce bio fuels [12]. The strength of bio energy program in India will mainly focus on the India's agriculture to increase the crops yield [13]. Complex methods of biogas production and its utilization have been developed to achieve the goals of both renewable energy and waste disposal [14]. India has a large amount of livestock about 512.05 million. The total estimated potential of BGP is 12 million but till now 4 million plants are installed which can generate daily on an average basis of about 35 million cubic meters of biogas. So that there is only near about 33% of the potential over the period of almost 40 years. According to a recent survey ten kilograms of cattle dung per day yields 0.36 cubic meters of biogas and fifteen kilograms of buffalo dung yields 0.54 cubic meters of biogas [15]. Various conversion techniques have been used for the conversion of biomass into biofuel in the three states of solid, liquid and gas [16]. The process called fermentation is used by bacteria and other micro-organisms to produce biogas with materials such as sewage, green waste, municipality waste, manure, plant and animal remains in the absence of oxygen [17]. Inside the biogas plant two types of reaction takes place. One is aerobic and the other is anaerobic reaction. Aerobic reaction involves the use of oxygen by bacteria for their growth and the anaerobic reaction breaks down complex substances and produces a type of gas which is used as fuel for cooking is called biogas [18].

III. ORGANIC FARMING USING SLURRY

Organic farming is being practiced in almost all parts of India where there is cultivation of oranges, pepper, pineapples, ginger, turmeric, etc. Many macro and micro nutrients are present in the slurry obtained from the BGP. The nutrients include 'N' which comprises 1.8% P_2O_5 with an average content of 1.0%, 0.90% of K_2O and also manganese (Mn), zinc (Zn), iron (Fe) and copper (Cu) with average content of 188ppm, 144ppm, 3550ppm and 28ppm respectively. It also contains organic matter of 65% and the C/N ratio is about 10–15 [7]. The compost produced will always contain other metals in trace amount that serve as a vital role in the growth of organisms [19]. A two cubic meter of a BGP produces about 50 kg of slurry each day. And a time period of twenty days

will be required for obtaining one metric ton of fresh wet slurry. Fresh slurry is also enriched with azospirillum.

The wet slurry can also be mixed with other organic nutrients in the desired proportion as per the requirements of the plants [7]. Bio slurry not only induces flourishing growth of plants, but also increases the fertility of the soil [18]. Bio slurry which is obtained as a result of fermentation from the digester serves as a potent organic fertilizer because it retains the nutrients that are originally present. Proper utilization of bio-slurry gives a very good agricultural yield and also prevents depletion of nutrients in the soil of agricultural lands [20].

IV. COMPOSITION OF BIO SLURRY

The remains of fermentation after biogas formation are called slurry. Since it is obtained biologically, it is also called bio-slurry. The slurry contains the largest composition by mass with water, which are around 93% and rest of it which contains 4.5% of dry matter and 2.5% of inorganic matter. Slurry contains scum, liquid effluent, sludge and many other organic and inorganic substances. Scum is the fluid present above the surface of solid slurry. Liquid effluents contain some of the macro and the micro nutrients. The macro nutrients which is present in them are 'N', 'P' 'K' and other micro nutrients present in them are calcium, Mg, Fe, Mn, Zn. Sludge is the substances present as a residue in a biogas. The sludge materials can also be used as fertilizer for the plants. It contain very high amount of nutrients and it can be settled in the bottom of the digester for many years [8].

Table I- Nutrients in different organic substances

Parameter	Composition of Nutrients (%)		
	Nitrogen	Phosphorous	Potassium
Cow dung	2.5	0.2	0.5
Sludge	3.5	4	0.6
Neem cake	5.2	1	1.8
Compost	1.8	1	1.4
Groundnut Cake	7.3	2.5	2
Castor cake	4.3	2.4	2.3

When the bio-slurry is exposed for a long period in the atmosphere, the 'N' which is present in the slurry will be lost and it destroys the quality of the fertilizer. The use of bio-slurry for seeding and conditioning of ponds for the fresh water fishes, the growth of fish increases and the net productivity will be more [18]. When the bio slurry is used in the compost form, then the ammonia present in the bio slurry will be lost which is the basic source for 'N' [8]. Bio slurry can be composted by mixing it with organic materials such as food waste, kitchen waste, dung and most other types of organic materials and straws. Nitrogen in the form of ammonia which is present in the bio-slurry will be partly taken by the plants and remains in the form of 'N'. Fresh slurry is also enriched with azospirillum.

It is an efficient ‘N’ fixing organism in microscopic scale. It also acts as a bio-fertilizer [7]. When compared with farm yard manure, bio-slurry will have high organic content. Bio-slurry should have higher pH than the farmyard manure [6]. Bio slurry is inexpensive, it does not pose any health hazard, which is eco-friendly to the nature and it produce better agricultural crops [21]. Recycling of organic waste such as cattle dung, vegetable waste, food waste by the process of anaerobic digestion in the BGP that will great potential than producing any other fossil fuels. In many of the developing countries like India, cattle dung, crops residues will be produced in very large amount and hence it possible for producing biogas and the bio slurry as the by-product. ‘N’ which is present in the bio slurry will be evaporated when it is exposed to the sun-light and when it is leaching in the rain. The use of bio slurry as the ‘N’ as a fertilizer will improves the corn yield [3]. ‘N’ and carbon which are present in the bio slurry will provide the sufficient nutrients which are required for both plants and soil. The bio-slurry will replace the synthetic fertilizers. India produces 730MT of animals dung per annum and 60% of the dung will be recoverable. Approximately if use 1kg of the cattle dung then we get about 0.3% of the bioslurry. Approximately the nutrient content of the bio slurry should contain 1.4-1.8% of ‘N’, 1.1-2% of ‘P’, 0.89-1.2% of ‘K’. The toxic materials which is present in the bio-slurry will be very less when compared with the other chemical fertilizers. Hence the bio-slurry will have less toxicity and it will easily replace the other chemical fertilizers.

V. CHARACTERISTICS OF DIGESTED BIO-SLURRY

Bio slurry being fully fermented, it is odorless and it does not attract flies. It also repels the termites and pests that are attracted to raw dung. Bio slurry reduces weed growth. Application of bio slurry has proved to reduce weed growth upto 50%. Bio-slurry is an excellent soil conditioner, adds humus, and enhances the soil’s capacity to retain water. Bio-slurry is pathogen free. The fermentation of dung in the reactor kills organisms that cause plant disease [20]. Synthetic fertilizers increase the soil’s nutrients more than organic fertilizers but they could only provide specific nutrients to the crops. If only synthetic chemical fertilizers are used it reduces the soil productivity. Synthetic fertilizers are expensive and not affordable for small scale farmers. But B-GS reduces the cost of natural organic fertilizer and increases the fertility of the soil. One cubic meter of bio-slurry contains 0.16 to 1.05 kilogram of ‘N’ that is almost equal to 0.35 to 2.5 kilogram of Urea. 76.8 MT of slurry contains 1.15 MT of ‘N’. Bio-slurry can reduce the use of other synthetic fertilizer to about 15 to 20 % [15]. The benefits on the usage of bio-slurry is that they replace expensive synthetic fertilizers and thus reducing the production cost and also makes the soil to adapt to different climatic hazards[22]. The following table shows the parameters its range, etc.

Table II: Physico-chemical composition of bio gas taken from 2D BGP [23].

Parameters	Range	Average ± SE
Ph value	7.8-8.1	7.9±0.16
N (%)	1.94-2.26	2.1±0.16
P (%)	0.98-1.14	1.1±0.07
K (%)	0.88-1.1	0.98±0.13
Fe (ppm)	0.33-0.35	0.34±0.03
Cu (ppm)	0.003-0.006	0.004±0.01
Mn (ppm)	0.084-0.092	0.008±0.01
Zn (ppm)	0.022-0.024	0.023±0.00

VI. RESULT

Usage of Bio slurry as a fertilizer uses the optimum usage of bio resources that is used for the production of bio gas and the leftovers are used as fertilizer. Bio slurry acts as an organic fertilizer that facilitates plant growth without any type of contamination. It also enriches the soil and thus improves the fertility of the soil. Synthetic fertilizers cause many ill effects to the land. Bio slurry is safe to use as it is a natural product. The necessary nutrients required for plant growth such as Potassium, Nitrogen and phosphorous are abundantly present in bio slurry.

VII. CONCLUSION

Energy resources play an important role for the development of any country. As on September 2018 installed capacity (IC) of renewable energy was 21.41% out of these 2.7% comes from bio energy in India. It is expected that the global bio energy I.C is expected to reach 165.1 GW in 2025. Biomass resources encompass a wide spectrum of residual materials such as forest, agriculture, aquaculture and organic wastes. Biomass is expected to become one of the key energy resources for global sustainable development. The production, applications, compositions and characteristic of bio slurry are studied in this paper. Biomass is converted into bio gas and bio slurry by various biomass conversion technologies with different types of BGPs. Bio slurry is the one of the good source of the organic fertilizer, which improves the quality of crops and improves the plant growth. It will provide the sufficient nutrients for the plants and it also has the very low amount of heavy metals when compared to the synthetic fertilizers. This paper encourages the researchers to produce biogas from different biomaterials and it motivates to analyze the effect of slurry on the growth of plants and further it motivates the researchers to do future studies on biomass.

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