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EXPERIMENTAL INVESTIGATION ON BIOGAS PRODUCTION USING HEN MANURE, FRUITS AND VEGETABLES

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Abstract. Experimental investigation on biogas production using hen manure, fruits and vegetables are analyzed in this paper. Mixes were prepared from mentioned organic waste: hen manure was mixed with fruits and vegetables in proportions 75:25, 50:50 and 25:75. Quality and quantity of biogas was researched in this work: quantity of produced biogas, concentration of methane, sulphur hydrogen and oxygen, variation of temperature and pH level through whole experiment time. There was measured that largest amount of produced biogas was 0.12 m^3 through whole experiment time on psychrophylic conditions when mix of hen manure with fruits and vegetables in proportion 75:25 biodegraded. Concentration of methane using this mix also was the highest and average value reached 31%. Evaluating amount of produced biogas and methane concentration it was determined that the most efficient using of produced biogas from hen manure with fruits and vegetables mix proportion is 75:25.

Keywords: biogas, biomass, hen manure, fruits and vegetables, psychrophylic conditions

1. Introduction

In these days in the world question of using alternative energy gets more and more actual and organic waste more and more are used for alternative energy [1-3].

In Lithuania as in many other countries one of the biggest problems is large amount of wastes. Between all waste not less amounts of organic waste consit. Under EU requirements amounts of organic waste eliminated to landfills should be reduced [4].

When organic waste biodegrades, gas containing methane, carbon dioxide, hydrogen and sulphur hydrogen emits. It should be noticed that methane stimulates greenhouse effect for 21 time more than carbon dioxide [5]. Inorganic compounds containing waste getting with fertilize to soil, has negative affect for soil structure and fecundity and disease makers cause danger to animal and human helth. Also there is large danger of surface and underground pollution [6,7].

One of the most perspective methods to convert organic waste to energy and get fertilize is anaerobic digesting of organic waste in bioreactors were biogas produced [8-10].

Organic waste useful to process on anaerobic conditions are all organic waste consisting in agriculture, stockbreeding, part of municipal waste, sludge of waste water treatment plants and technological waste of food recast industry (if they don't used for other purpose) [6]. Applying of anaerobic treatment of organic waste enable to reduce areas of useful land used to keep these waste, noxiousness of waste and their negative impact to environment.

Main part of organic waste in agriculture consist in stockbreeding and aviculture farms. Large amounts of organic waste consist in market centers. When expiry of products is finished or marketable appearance is lost, food eliminated to companies treated these waste.

Experimental investigation on biogas production using hen manure, fruits and vegetables are analyzed in this work. Amount of proteins, carbohydrates is almost the same in hen manure and in fruits and vegetables the largest amount has carbohydrates. Increasing amount of carbohydrates in substrate biological digesting process accelerates because carbohydrates biodegrades fster [11, 12].

Qualitative and quantitative composition of biogas is analyzed: amount of produced biogas, concentration of methane, sulphur hydrogen and oxygen, variation of temperature and pH level through whole experiment time.

There was measured witch of analyzed mixes produced more biogas and methane when organic waste biodegraded.

2. Purpose of investigation

Purpose of investigation – analyze qualitative and quantitative composition of biogas from mixes made of hen manure, fruits and vegetables.

3. Methods

When investigating the qualitative and quantitative composition of biogas, the biomass (organic waste) of different compositions, i.e. hen manure, fruits and vegetables mixed at the ratios of 75:25, 50:50 and 25:75, was used.

Anaerobic degradation of mixtures of these organic wastes was performed in bioreactors united into a single system (Fig 1).

Plastic closed tanks of 220 l capacity, each, were used in bioreactors and anaerobic conditions were created in them. 200 l (90 %) of the tanks were filled up, and the remaining part was left for gas accumulation.

Prior to the experiment, a substrate containing 20% of dry substance of its total mass was prepared.

Every bioreactor had a mixing system, a thermometer, a sampling place for determining pH and a gas meter.

Prior to measuring, the substrate was mixed up with the mixer so as to obtain a uniform phase within its entire volume. After mixing up the substrate, the tap was opened to let the accumulated biogas flow via hoses passing the gas-flow meter and afterwards – the gas analyser. The amount of evolved biogas, and the concentrations of methane, sulphuretted hydrogen and oxygen in the evolved gas were determined.

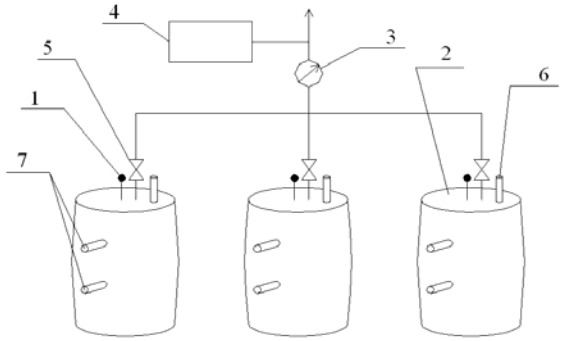

Fig 1. The system of bioreactors: 1 – bioreactor's mixer, 2 – bioreactor, 3 – gas meter, 4 – gas analyser,5 – tap, 6 – sampling place to determine pH, 7 – thermometers

4. Results and discussion

During biological degradation of *hen manure, fruits and vegetables (the ratio of 75:25)* the recorded amount of gas emissions was 0.0039 m^3/d, which rapidly grew until the 9th day of the experiment when gas output reached 0.0049 m^3/d. Until the 13th day of the experiment gas output was decreasing up to 0.0055 m^3/d and further decreased to 0.0029 m^3/d.

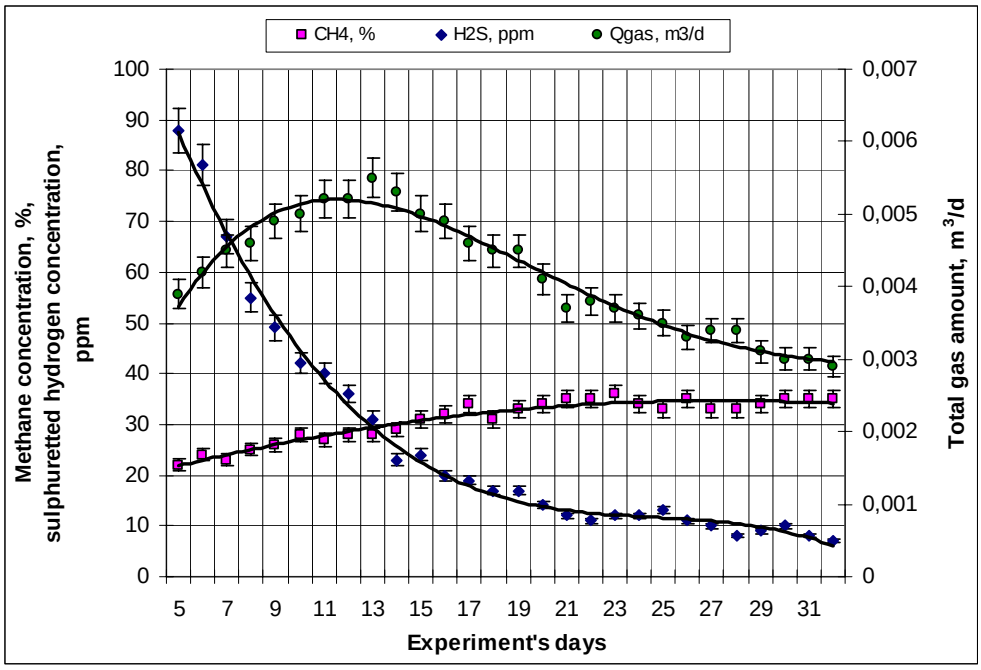

Fig 2. Methane, sulphuretted hydrogen and gas amount during biological degradation of hen manure, fruits and vegetables (the ratio of 75:25)

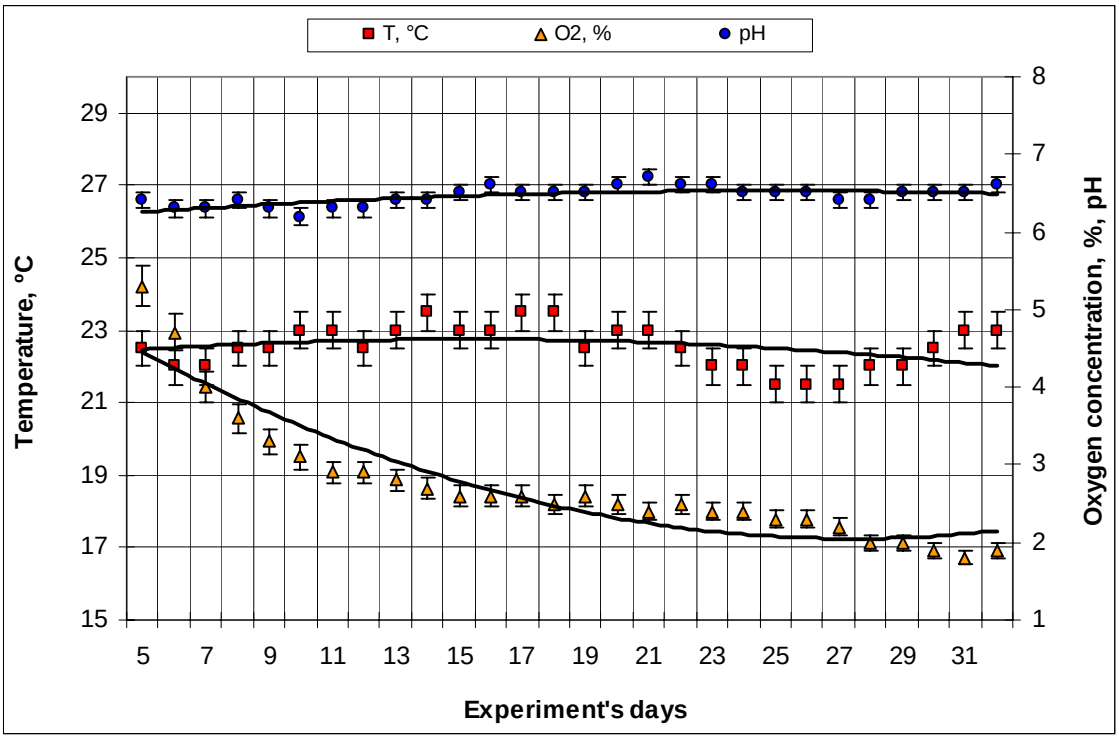

Fig 3. Temperature, oxygen concentration and pH during biological degradation of hen manure, fruits and vegetables (the ratio of 75:25)

During the first part of experiment concentration of sulphuretted hydrogen rapidly decreased and from 88 ppm at start of the experiment to 17 ppm till 18th day of the experiment. Such a rapid decrease could be predetermined by fast activity of bacteria. Later the amount sulphuretted hydrogen was insignificantly decreasing and concentration of sulphuretted hydrogen in biogas emissions decreased to 7 ppm to the end of the experiment.

The concentration of methane from start to 23th day the experiment was gradually increasing and later till the end of the experiment despite small fluctuations, which were predetermined due to variations in temperature and pH. At start of the experiment in biogas there were 22 % of methane, highest concentration reached 36 %. Later to the end of the experiment concentration of methane was about 34 %.

During the experiment temperature varied from 22 °C to 23.5 °C, but the absence of tendency, the average temperature in bioreactor was around 22.6 °C. Little fluctuations of temperature haven't affect on processes in bioreactor, because temperature variation by 3 degrees in one hour is permissible [5].

Throughout the experiment the concentration of oxygen in produced biogas was decreasing from 5.3 % at the beginning to 1.9 % at the end of the experiment

During anaerobic degradation of hen manure, fruits and vegetables (25:75) pH varied from 6.2 to 6.6, but throughout the experiment no clear tendency was noticed and the average pH value was 6.4 – i.e. of very low acidity. Such pH indicator could be predetermined because bacteria could not be active in degrading fatty waste [12].

During biological degradation of hen manure, fruits and vegetables (at the ratio of 50:50), like in the previous case, at the beginning gas emissions rapidly increased but afterwards decreased gradually. At the start of the experiment amount of biogas was 0.0034 m^3/d, till 11th day reached 0.050 m^3/d. later amount of produced gas started decrease – till the end of the experiment decreaced to 0.0028 m^3/d.

During the first part of experiment concentration of sulphuretted hydrogen rapidly decreased and from 59 ppm at start of the experiment to 21 ppm till 17th day of the experiment. Such decrease could be predetermined by fast activity of bacteria [12]. Later concentration of sulphuretted hydrogen was insignificantly decreasing and concentration of sulphuretted hydrogen in biogas emissions decreased to 7 ppm to the end of the experiment.

During whole experiment concentration of methane had rising tendency despite small fluctuations, which were predetermined due to variations in temperature and pH. At the beginning of experiment in biogas there were 17 % of methane, highest concentration reached 31 % at the end of the experiment.

During the experiment temperature varied from 21 °C to 23.5 °C, low decreasing temperature tendency mentioned, the average temperature in bioreactor was around 22.4 °C.

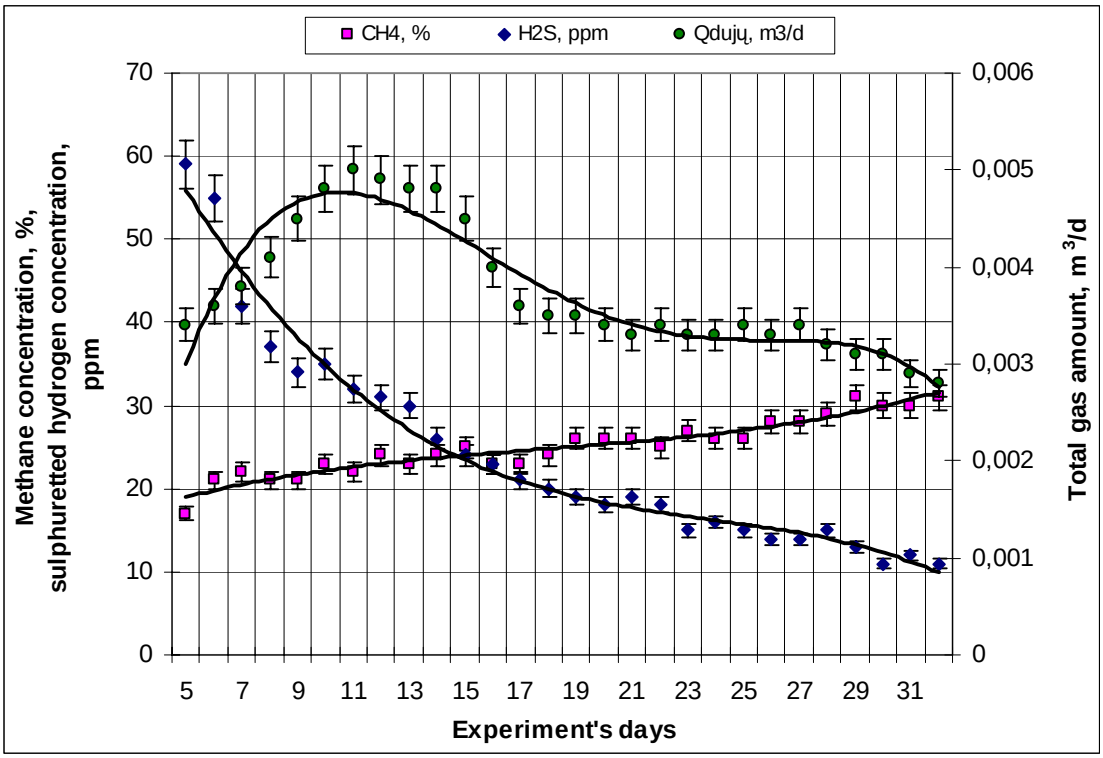

Fig 4. Methane, sulphuretted hydrogen and gas amount during biological degradation of hen manure, fruits and vegetables (the ratio of 50:50)

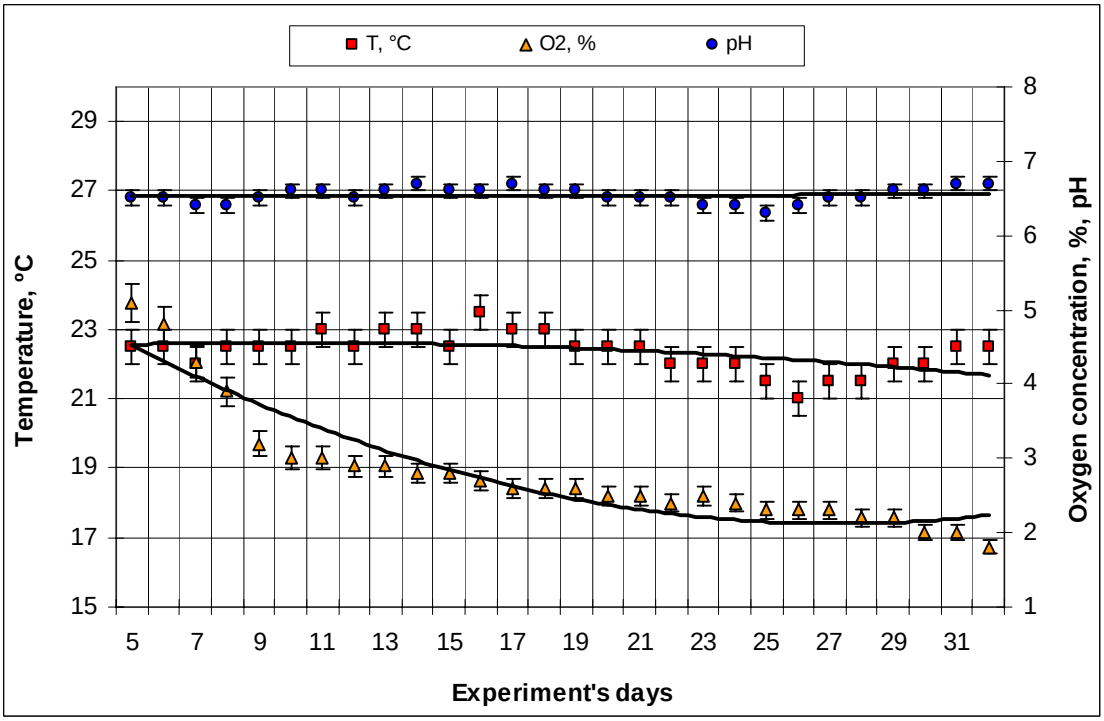

Fig 5. Temperature, oxygen concentration and pH during biological degradation of hen manure, fruits and vegetables (the ratio of 50:50)

Throughout the experiment the concentration of oxygen in produced biogas was decreasing from 5.1 % at the beginning to 1.8 % at the end of the experiment.

During anaerobic degradation of hen manure, fruits and vegetables (50:50) pH varied from 6.3 to 6.7, but throughout the experiment no clear tendency was noticed and the average pH value was 6.5 – i.e. of

very low acidity. Such pH indicator could be predetermined because bacteria could not be active in degrading fatty waste.

During biological degradation of *hen manure, fruits and vegetables (the ratio of 25:75)* the recorded amount of gas emissions rapidly grew and when at 10th day reached maximum value started decreased. At the beginning of experiment amount of produced biogas was 0.0029 m^3/d, which until the 10th day of the experiment reached 0.0047 m^3/d. Later amount of produced gas was decreasing and to the end of experiment decreased to 0.0020 m^3/d.

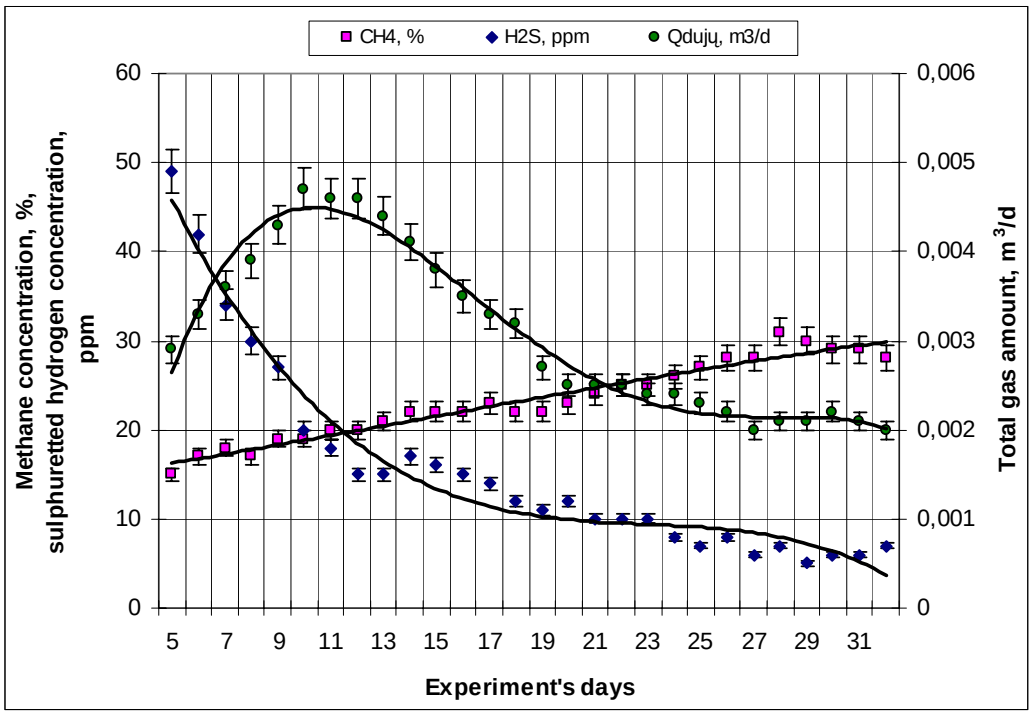

Fig 6. Methane, sulphuretted hydrogen and gas amount during biological degradation of hen manure, fruits and vegetables (the ratio of 25:75)

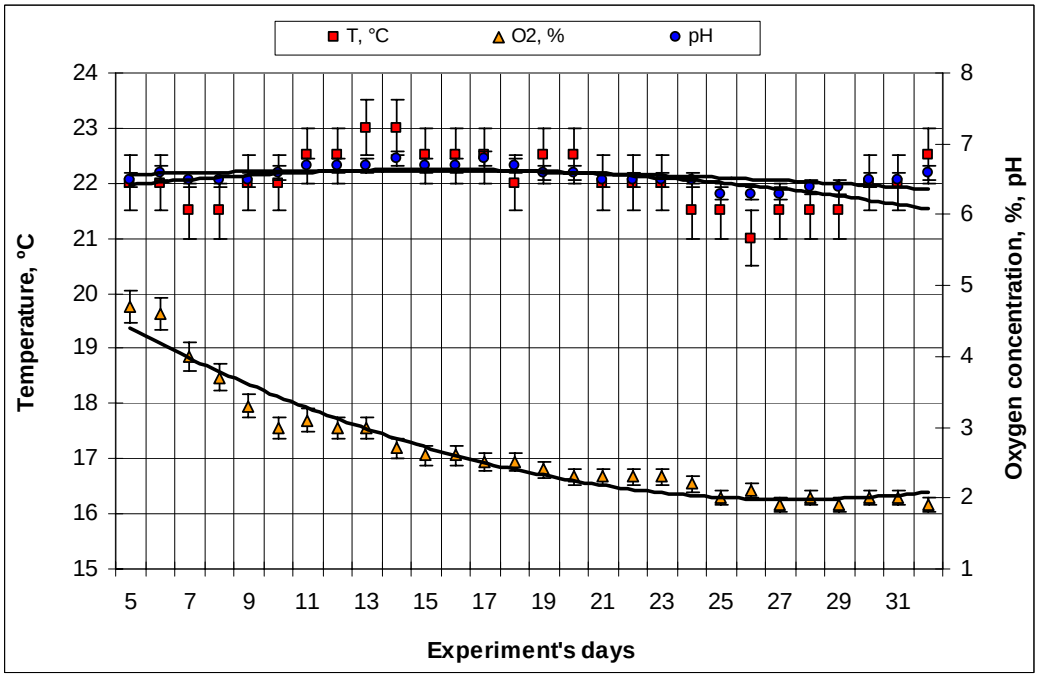

Fig 7. Temperature, oxygen concentration and pH during biological degradation of hen manure, fruits and vegetables (the ratio of s 25:75)

During the first part of experiment concentration of sulphuretted hydrogen decreased from 49 ppm to 15 ppm till 12th day of the experiment. Such a rapid decrease could be predetermined by fast activity of bacteria. Later the amount sulphuretted hydrogen was insignificantly decreasing and concentration of sulphuretted hydrogen in biogas emissions decreased to 7 ppm to the end of the experiment.

Concentration of methane had rising tendency throughout experiment. Noticeable fluctuations were mentioned only at the end of experiment when average concentration of methane gets steadier and little (3 %) decreased. During whole experiment concentration of methane had small fluctuations, which were predetermined due to variations in temperature and pH. At the beginning of experiment concentration of methane was 15 %, maximum concentration was 31 % at 28th day and 28 % at the end of experiment.

During the experiment temperature varied from 21 °C to 23 °C, low decreasing temperature tendency mentioned at the end of experiment, the average temperature in bioreactor was 22.1 °C.

Throughout the experiment the concentration of oxygen in produced biogas was decreasing from 4.7 % at the beginning to 1.9 % at the end of the experiment. Concentration of oxygen in biogas decreasing tendency mention, witch gets not so directional and more steady at the end of experiment.

During anaerobic degradation of hen manure, fruits and vegetables (25:75) pH varied from 6.3 to 6.8, but throughout the experiment no clear tendency was noticed and the average pH value was 6.6 – i.e. of very low acidity. Such pH indicator could be predetermined because bacteria could not be active in degrading fatty waste.

5. Conclusions

1. Throughout the experiment, the highest biogas production – 0.12 m^3 – was achieved using the mixture of hen manure, fruits and vegetables at the ratio of 75:25.
2. The highest biogas production using different content of mixures was measured on 11th -13th days of experiment and reached from 4.7 to 5.4 liters per day.
3. Adding more fruits and vegetables in mix biodegrading was faster – amount of produced biogas was higher in first days of experiment and earlier got lower.
4. Concentration of methane in produced biogas was getting higher at all experiments. The highest change was measured biodegrading mix of hen manure, fruits and vegetables in ratio 75:25. concentration of methane changed from 22 % to 35 %.
5. The highest concentration of methane was measured using mix of hen manure, fruits and vegetables in ratio 75:25. Average concentration of methane was 31 % at experiment.
6. The analysis amount of produced gas and methane concentration in gas shows that the biogas produced from hen manure, fruits and vegetables mixed at the ratio of 75:25 is the most efficient for use.
7. Higher amount of biogas and concentration of methane is when there is more valuable hen manure, but mixing it with fruits and vegetables producing of biogas get faster.

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