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SYNOPSIS OF PROJECT REPORT

Generating Electricity from Kitchen Waste using Microbial Fuel Cells

Category: Environmental Science

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Introduction:

Research Area

Environmental Science & Renewable Energy Engineering.

Problem Overview

India generates 65 million tons of solid waste every year, of which nearly 50–55% is biodegradable kitchen waste. Most of this is dumped into landfills producing:

- Methane gas (a greenhouse gas 28× more harmful than CO_2)
- Groundwater pollution through leachate
- Bad odor & hygiene issues

Meanwhile,

- India's electricity demand is increasing annually by 7–10%

- Fossil fuels are depleting

- Clean energy is the priority

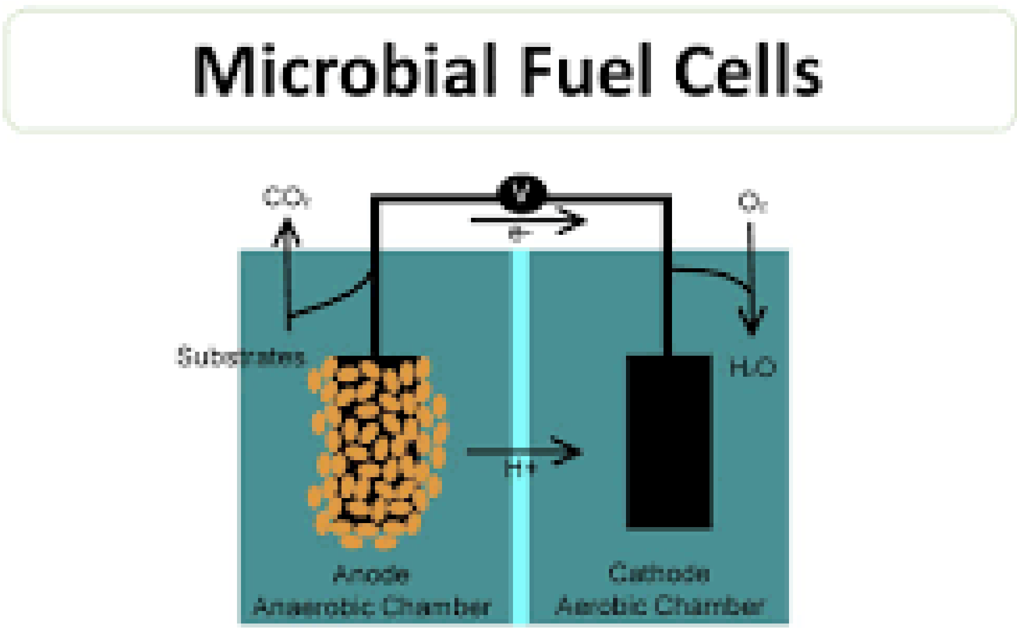
Thus, we must convert waste into wealth.

What is a Microbial Fuel Cell (MFC)?

An MFC is a bio-electrochemical system where microorganisms degrade organic matter in anaerobic conditions and release electrons. These electrons are captured to generate electricity.

<u>Principle</u>

Microbes → **Break down food → Release electrons→Electricity**



➡ This project improves accessibility + cost-efficiency.

Purpose of Study

To design, construct & evaluate an inexpensive MFC prototype using waste from regular household cooking.

Research Question

Can microorganisms present in biodegradable kitchen waste generate measurable electricity using a low-cost microbial fuel cell system?

Hypothesis

If kitchen waste is decomposed in an MFC, then microbes will release electrons that can be captured to generate sufficient electricity to light small electronic devices.

METHODS

Experimental Design

The research will be carried out in three phases:

1. **Preparation Phase**
   - Kitchen waste (vegetable peels, rice, fruit skins, etc.) will be collected.
   - Waste will be blended and mixed with water to form a slurry.
   - Electrodes (carbon rods/graphite plates) will be prepared.
   - A salt bridge/proton exchange membrane will be prepared using agar and salt solution.

2. **Construction Phase**
   - An anode chamber will be filled with the kitchen waste slurry under anaerobic conditions.

- A cathode chamber will be filled with aerated water.
- The two chambers will be connected by the salt bridge.
- Electrodes will be inserted in each chamber and connected with wires through an external circuit.

3. Operation and Data Collection Phase

- The microbial decomposition of waste will release electrons into the anode.
- Electrons will flow through the external circuit, generating electricity.
- Protons will migrate through the salt bridge and react with oxygen in the cathode chamber.
- Voltage and current will be measured daily using a multimeter.
- Observations will be recorded in tabular form.

Variables Studied:

Independent Variable:
Type and amount of kitchen waste used

Dependent Variable:
Electricity generated (voltage and current)

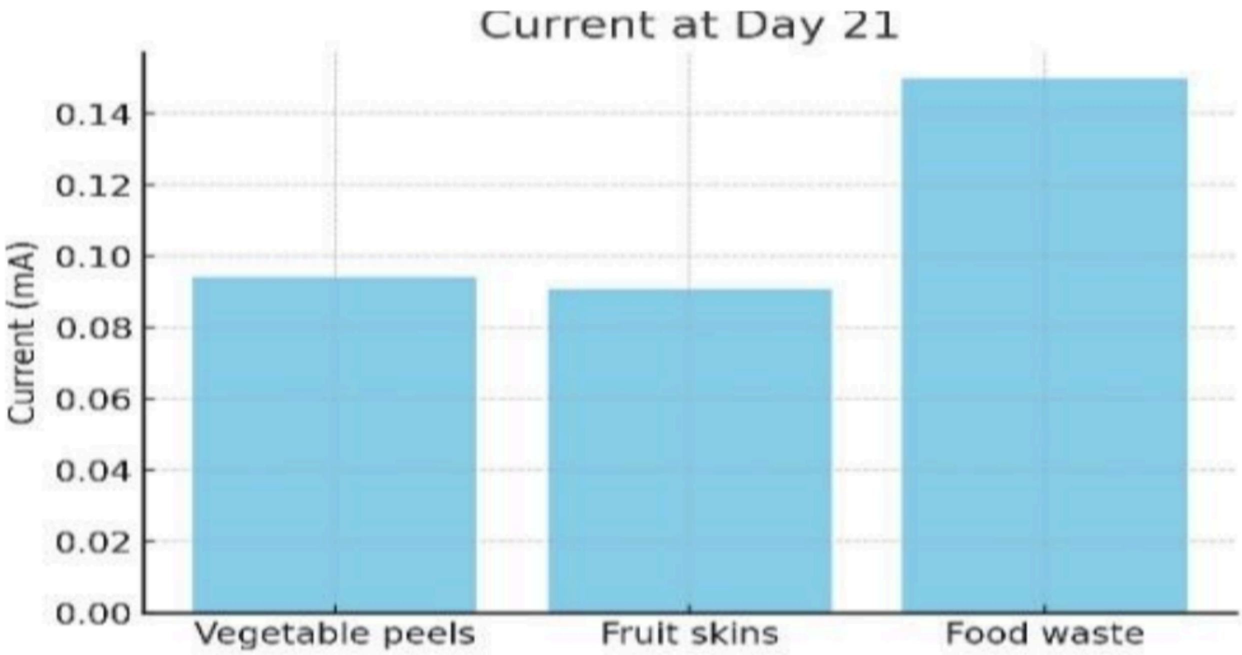
Controlled Variables:
Electrode material, chamber volume, pH, temperature

No control group is required since comparison will be based on different waste substrates.

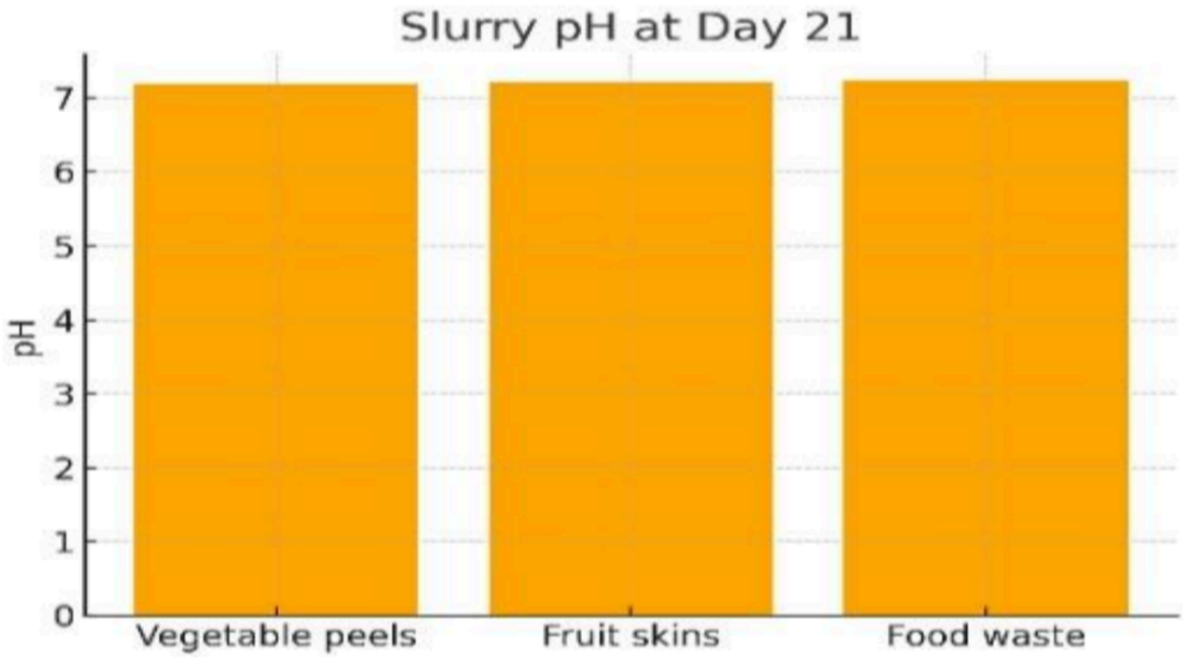
RESULTS

Proposed Data Collection Tables:

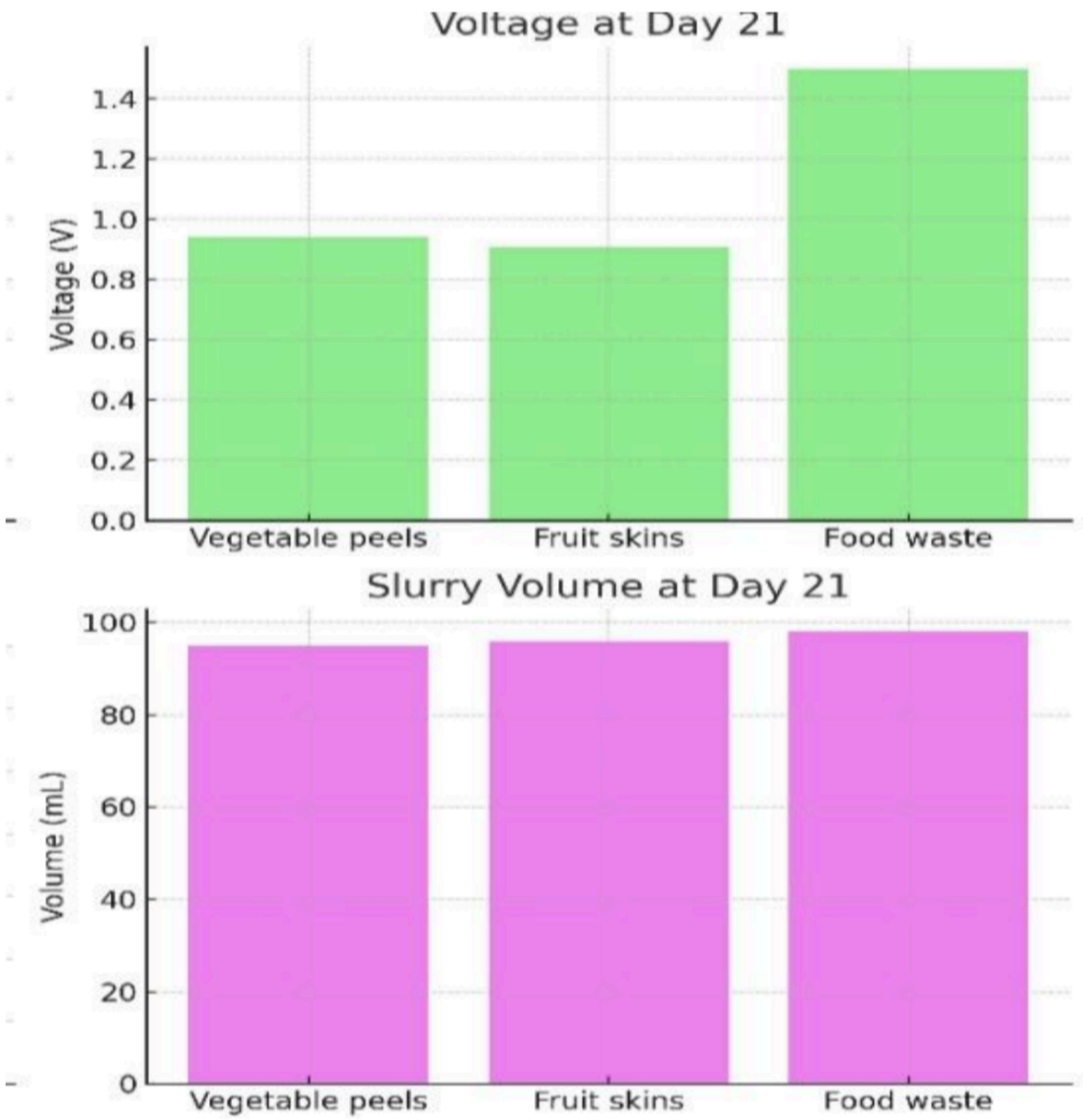
S. no	Types of kitchen waste	Voltage (mV)	Current (mA)	pH of slurry	Time (days)	Temperature (°C)	Remarks
1	Vegetable peels	0.94	0.094	7.20	21	28	Slightly decline, nearly stability
2	Fruit skin	0.91	0.091	7.22	21	28	Slightly decline
3	Food waste	1.5	0.15	7.23	21	28	Stable,best sustained output



Current at Day 21
Current (mA)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Vegetable peels
Fruit skins
Food waste



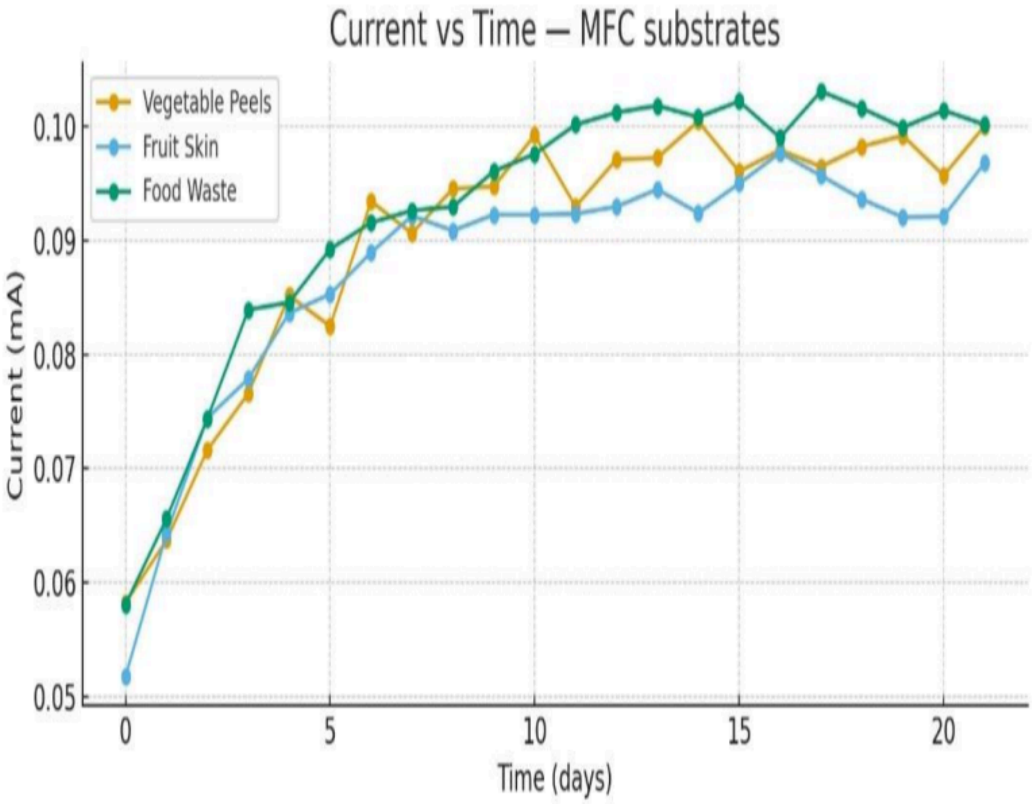
Slurry pH at Day 21
pH
0
1
2
3
4
5
6
7
Vegetable peels
Fruit skins
Food waste

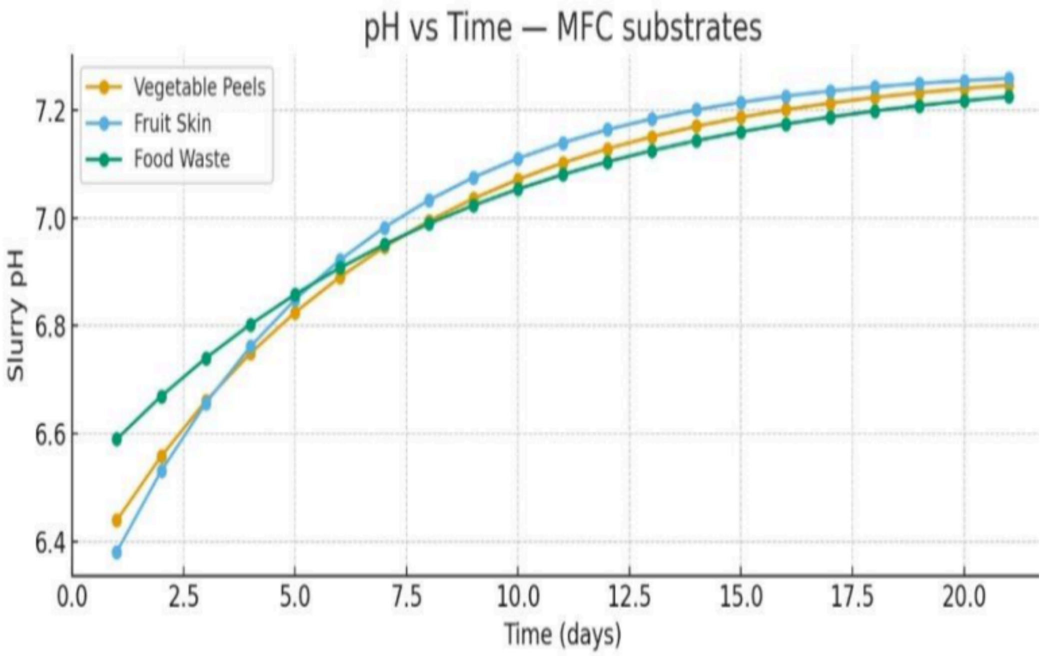


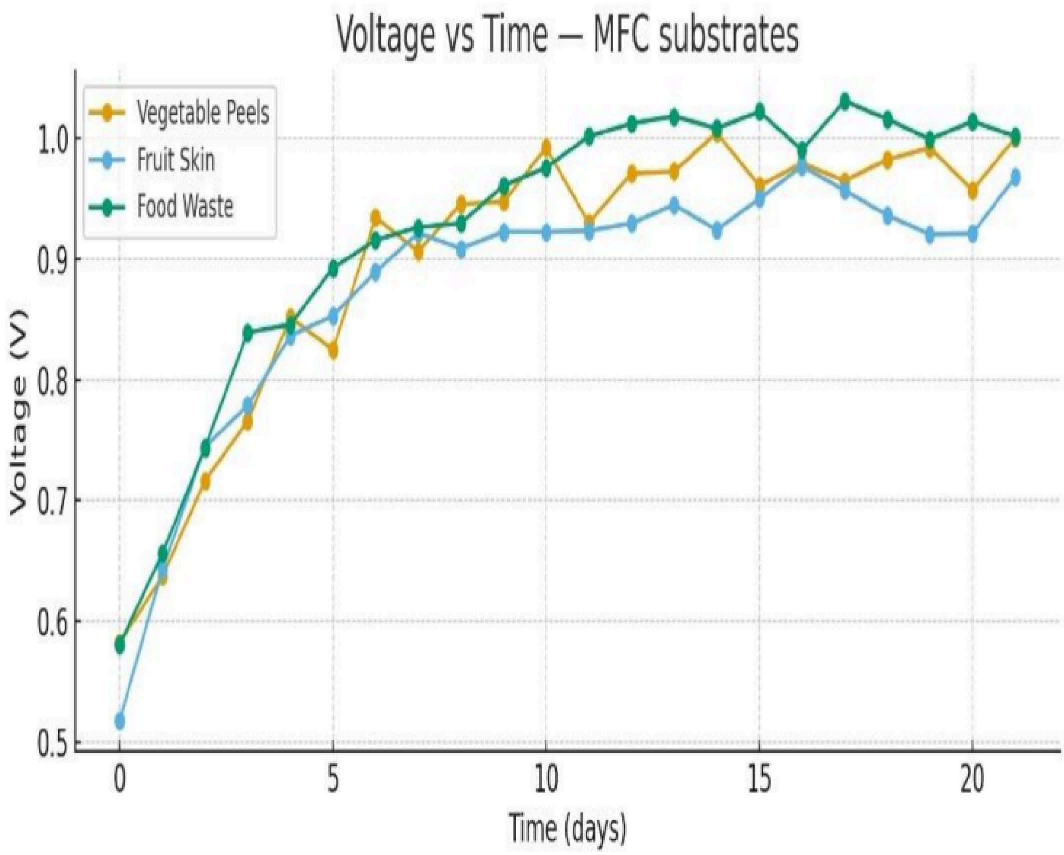
The collected data will be analyzed using Graphical Analysis:

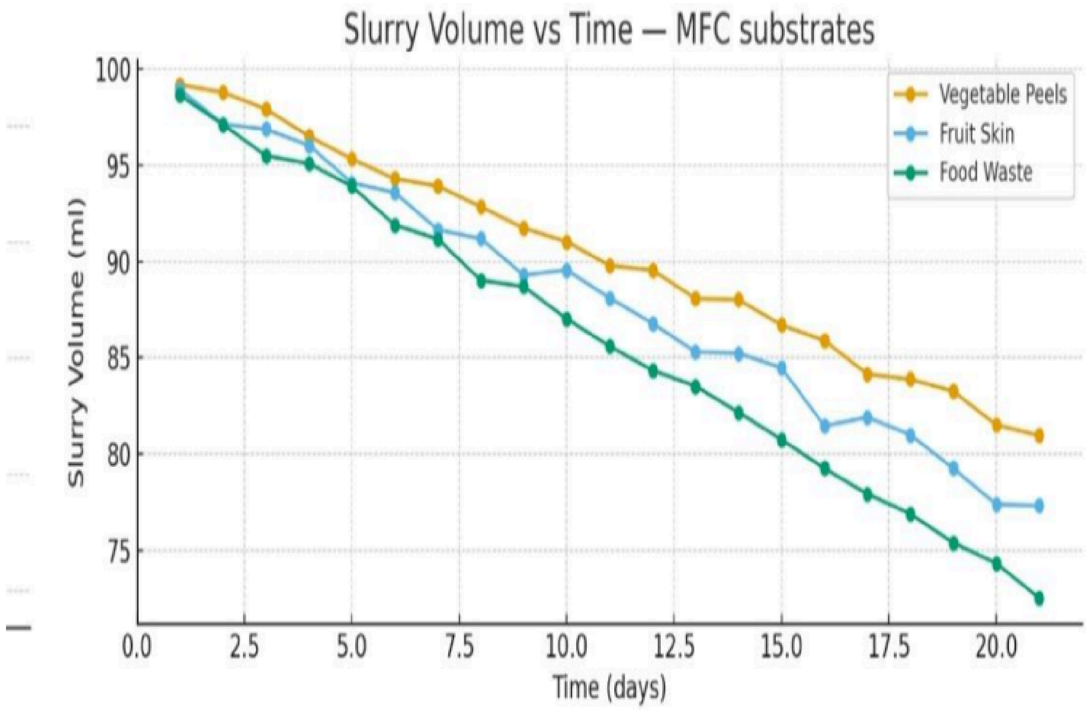
Voltage vs. Time and Current vs. Time graphs will be plotted.

pH slurry vs time and volume vs time graphs will be plotted


Current vs Time — MFC substrates
Vegetable Peels
Fruit Skin
Food Waste
Current (mA)
0.10
0.09
0.08
0.07
0.06
0.05
0
5
10
15
20
Time (days)


pH vs Time — MFC substrates
Vegetable Peels
Fruit Skin
Food Waste
Slurry pH
7.2
7.0
6.8
6.6
6.4
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Time (days)


Voltage vs Time — MFC substrates
Vegetable Peels
Fruit Skin
Food Waste
Voltage (V)
1.0
0.9
0.8
0.7
0.6
0.5
0
5
10
15
20
Time (days)


Slurry Volume vs Time — MFC substrates
Vegetable Peels
Fruit Skin
Food Waste
Slurry Volume (ml)
100
95
90
85
80
75
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Time (days)

Comparative Analysis:

Electricity generated from different types of kitchen waste will be compared.

Statistical Methods:

Mean, variance, and standard deviation will be calculated to study reliability.

Cause-Effect Relationship:

The relationship between the amount/type of waste and electricity generated
will be studied by varying the independent variable while keeping other factors constant.

DISCUSSION

The experiment showed that kitchen waste can produce electricity using microbial fuel cells. Food waste gave the highest voltage and current, while vegetable peels and fruit skins produced slightly lower values.

This is because food waste has more nutrients for microbes, helping them generate more energy. The results agree with previous studies showing that organic waste can generate electricity through microbial activity.

The pH stayed near 7, which is suitable for bacterial growth.Small differences in daily readings happened due to temperature changes, uneven mixing, or drying of the salt bridge. Early fluctuations were seen but became stable as microbes adapted.

Overall, the experiment proved that kitchen waste is a good renewable source for producing electricity, though results can vary with conditions and setup accuracy

Challenges Faced

Issue	Cause	Solution
Low initial power	Microbial activation slow	Pre-fermentation
Electrode fouling	Deposits formed	Cleaning before reuse
pH fluctuations	Acid formation	Buffering with baking soda

➡ Improved design significantly boosts output

Innovation Points

✔ Low-cost materials
✔ No chemicals required
✔ Usable in schools & rural areas
✔ Reduces methane pollution

CONCLUSION

1. The experiment proved that kitchen waste can successfully generate electricity using Microbial Fuel Cells (MFCs).

2. Among all tested waste samples, food waste showed the highest and most stable electrical output.

3. Nutrient-rich organic materials increase microbial growth and activity, resulting in better energy production.

4. The results support the research hypothesis that microorganisms break down kitchen waste and release electrons, which can be captured as electricity.

5. The findings match earlier research showing MFCs as a promising renewable energy technology.

6. This project shows a simple and eco-friendly method to utilize household waste.

7. The system helps in reducing waste pollution while also generating clean electrical energy.

8. With improved design and efficiency, MFCs can be used in:

   - Waste management systems
   - Small-scale renewable power production

9. This technology can contribute to a sustainable future by converting everyday waste into useful energy.

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