PROJECT TITLE: BIOFUELS FROM FRUITS AND VEGETABLES: PRODUCTION OF BIOETHANOL FROM BANANA, POTATO, AND ORANGE PEELS.

PARTICIPANT NAME: M. HUMAIRA

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SCHOOL: MOUNT HIRA MATRICULATION SCHOOL

CITY AND STATE: NELLIKUPPAM,
TAMILNADU (CUDDALORE DISTRICT)

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I. ABSTRACT :

PROJECT TITLE: "BIO FUELS FROM FRUITS AND VEGETABLES: PRODUCTION OF BIO ETHANOL FROM BANANA, POTATO, AND ORANGE PEELS".

By Humaira. M Grade VI,
MOUNT HIRA MATRICULATION SCHOOL,
NELLIKUPPAM.

The rapid increase in energy consumption worldwide has created a demand for alternative, renewable sources of energy. Biofuels, derived from organic materials, offer a sustainable solution by reducing dependence on fossil fuels and minimizing environmental pollution. Fruit and vegetable waste, which is often discarded, contains significant amounts of carbohydrates including starch and sugars that can be converted into ethanol through microbial fermentation. This, project focuses on producing bioethanol from banana, potato, and orange peels, which are abundant kitchen wastes. The process involves cleaning and cutting the peels, grinding them into a slurry, boiling to release sugars, and fermenting the mixture using Saccharomyces cerevisiae (baker's yeast). The fermentation process converts sugars into ethanol and carbon dioxide over three to four days. After fermentation, the ethanol is collected by filtration, and its volume is measured to compare yields from the different peels.

The experiment showed that banana peels produced the highest ethanol yield, followed by potato peels, while orange peels produced the least ethanol. This result confirms that peels rich in starch and sugar are more effective in bioethanol production than fibrous peels. The study highlights the potential of utilizing fruit and vegetable waste as a raw material for renewable energy, transforming household waste into a valuable fuel resource. It demonstrates how simple fermentation techniques can convert waste into clean energy, encouraging students and households to adopt eco-friendly practices. The findings can serve as a model for small-scale biofuel production using readily available fruit and vegetable materials.

II. INTRODUCTION :

Energy is an essential component of modern life, powering homes, transportation, industries, and technology. However, the majority of energy used worldwide is derived from fossil fuels, such as coal, oil, and natural gas, which are non-renewable and contribute significantly to environmental pollution and climate change. The burning of fossil fuels releases carbon dioxide and other greenhouse gases, leading to global warming and depletion of natural resources. This situation has created a growing need for renewable and sustainable energy sources that are eco-friendly and capable of meeting the world's energy demands without harming the environment.

Biofuels are one of the most promising alternatives to fossil fuels. Derived from organic matter, biofuels can be renewable, carbon-neutral, and less polluting. Among the various types of biofuels, bioethanol is widely recognized for its clean-burning properties and its ability to be blended with gasoline for use in vehicles. Bioethanol can be produced from a range of biomass sources, including sugarcane, corn, and lignocellulose waste. One of the most accessible and cost-effective sources for bioethanol production is fruit and vegetable waste, which is generated in large quantities in households, restaurants, and markets.

Fruit and vegetable peels, such as those from bananas, potatoes, and oranges, contain significant amounts of carbohydrates in the form of starch and simple sugars. These carbohydrates can be converted into fermentable sugars through simple processing techniques like boiling and grinding. Microorganisms, particularly Saccharomyces cerevisiae (baker's yeast), can then ferment these sugars into ethanol and carbon dioxide under suitable conditions. The process of fermentation is environmentally friendly and provides a practical method to recycle organic waste into a useful form of energy.

The importance of using fruit and vegetable waste for biofuel production lies not only in energy generation but also in waste management. Organic waste that is discarded can lead to unpleasant odors, attract pests, and produce methane, a greenhouse gas that contributes to climate change. By utilizing peels and other biodegradable materials for ethanol production, the environmental impact of waste disposal can be reduced, and a sustainable energy source can be generated simultaneously.

"Biofuels are gaining importance as a renewable energy source, especially in countries like India is where reducing fossil fuel dependency is a priority. Fruits and vegetables like bananas, potatoes, and oranges generate a lot of waste in the form of peels. These peels, rich in sugars, can be converted into bioethanol through fermentation, a process that utilizes yeast to break down sugars into alcohol. By exploring the production of bioethanol from banana, potato, and orange peels, this project aims to tap into the potential of food waste for sustainable energy, potentially reducing environmental pollution and promoting a circular economy.

In addition to environmental benefits, producing bioethanol from fruit and vegetable peels provides educational opportunities. Students and communities can learn about renewable energy, microbiology, and chemistry through hands-on experiments. Small-scale bioethanol production can also inspire practical applications for energy generation at home or school level, demonstrating how everyday waste can be transformed into a valuable resource.

The production of bioethanol from fruit and vegetable waste addresses multiple challenges, including energy sustainability, waste management, and environmental conservation. This project focuses on banana, potato, and orange peels to explore their potential as renewable fuel sources, highlighting the connection between science, sustainability, and practical problem-solving in daily life.

Purpose of the Project:

Food waste is a growing problem worldwide, and improper disposal of organic waste has serious environmental consequences. Fruit and vegetable peels, which are often thrown away in households and markets, decompose rapidly and produce unpleasant odors, attract pests, and release methane, a potent greenhouse gas that contributes to climate change. With the increasing awareness of sustainability and renewable energy, there is a need to find practical solutions that can reduce waste while providing an alternative source of energy. This project addresses this issue by exploring the potential of fruit and vegetable peels — specifically banana, potato, and orange peels — as raw materials for bioethanol production.

The purpose of this project is to explore the potential of utilizing banana, potato, and orange peels for the production of bioethanol, thereby converting food waste into a valuable renewable energy source. By investigating the bioethanol yield from these fruit and vegetable peels, this project aims to contribute to sustainable waste management practices and reduce dependence on fossil fuels. The findings of this study can provide insights into the feasibility of using food waste as a viable feedstock for biofuel production, promoting a circular economy and environmentally friendly energy solutions.

This project involves converting the carbohydrates present in these peels into fermentable sugars, which are then transformed into ethanol through microbial fermentation using Saccharomyces cerevisiae, commonly known as baker's yeast.
Banana and potato peels, being rich in starch, are expected to yield higher ethanol content, while orange peels, which contain less starch but some natural sugars and fiber, may produce lower amounts.
By examining the fermentation process, the project investigates the relationship between the type of peel, its sugar and starch content, and the resulting ethanol yield.

This study also demonstrates how a simple scientific experiment can address a real-world problem. It combines concepts from biology, chemistry, and environmental science to provide a practical solution to food waste management. By using locally available, low-cost materials, the project emphasizes that sustainable energy production does not always require advanced technology or expensive resources.
Instead, small-scale bioethanol production can be a feasible, eco-friendly practice at the household or school level.

In addition to energy production, the project aims to educate students and communities about the value of renewable resources and responsible waste disposal. By converting banana, potato, and orange peels into bioethanol, the project provides an example of how waste-to-energy solutions can be implemented in everyday life. It encourages innovative thinking, problem-solving, and environmental stewardship, while highlighting the scientific principles behind fermentation and biofuel production.

Research Question:

- Which of the three peels (banana, potato, or orange) yields the highest amount of bioethanol through fermentation?
- How does the sugar content in banana, potato, and orange peels affect bioethanol production?
- What is the effect of varying fermentation times on bioethanol yield from banana, potato, and orange peel?

Hypothesis:

- Bioethanol can be produced from the peels of banana, potato, and orange through fermentation.
- Different feedstocks (banana, potato, orange peels) will yield varying amounts of bioethanol due to differences in sugar content and composition.
- The efficiency of bioethanol production might depend on the pretreatment method used for the peels.
- Banana peels have high starch/sugar content.

To make bioethanol from fruit and vegetable peels, we need a few simple materials that are easy to find at home or in the lab. The main materials are banana peels, potato peels, and orange peels. These peels are rich in sugars and starch, which are the main food for yeast during fermentation. Banana peels have a lot of starch, potato peels also have starch, and orange peels have some sugar but are more fibrous.

We also need baker's yeast (Saccharomyces cerevisiae), which helps turn the sugars in the peels into ethanol and carbon dioxide. To help the yeast start working, a small amount of sugar is added. The pH of the mixture is adjusted using lemon juice or citric acid, which creates a slightly acidic environment that is good for the yeast and stops harmful bacteria from growing.

Water is needed to make a slurry, which is a smooth mixture of peels and water. The peels are ground in a blender or grinder to break them into small pieces. This makes it easier for the yeast to act on the sugars.

For fermentation, we use bottles or jars to hold the mixture. Balloons are placed on top of the bottles to trap the carbon dioxide gas released during fermentation.

Measuring cylinders, beakers, and spoons are used to measure the water, sugar, and yeast.

Thermometers and pH strips help check that the temperature and acidity are good for fermentation.

After fermentation, we separate the ethanol by filtering the mixture using a funnel and filter cloth or paper. In more advanced setups, a distillation kit can be used under supervision to get pure ethanol.

Safety equipment like gloves and goggles is important when handling hot liquids, acids, or ethanol.

These materials are easy to get and safe to use for a small experiment. They help show how fruit and vegetable waste can be turned into bioethanol, a renewable source of energy.

III. METHODOLOGY:

The procedure for producing bioethanol from banana, potato, and orange peels is simple and can be done with household materials. Follow these steps carefully to ensure good results and safety.

Step1: **Collecting and Preparing the Peels**

First, collect banana, potato, and orange peels. Wash them thoroughly to remove dirt, pesticides, or any chemicals. After washing, cut the peels into small pieces so they are easier to blend. Cutting the peels into smaller pieces increases the surface area, making it easier for the yeast to act on the sugars during fermentation.

Step2: **Making the Peel Slurry**

Put the cut peels into a blender and add water in a ratio of about 1 part peel to 5 parts water. Blend the mixture until it becomes a smooth slurry. This slurry will be the main substance that the yeast will ferment to produce ethanol.

Step3: **Boiling the Slurry**

Pour the slurry into a pot and boil it for about 10–15 minutes. Boiling helps to release the sugars from the peels and also kills any harmful bacteria that might interfere with fermentation. After boiling, allow the mixture to cool down to room temperature before adding the yeast.

Step4: **Adjusting the pH**

Check the pH of the cooled slurry using pH strips or a pH meter. The ideal pH for yeast fermentation is around 4.5 to 5.0. If necessary, add a few drops of lemon juice or citric acid to adjust the acidity. This helps the yeast grow well and prevents unwanted microorganisms from developing.

Step5: **Preparing the Yeast**

Take baker’s yeast and mix it with a small amount of warm water and 1 teaspoon of sugar. Let it sit for 5–10 minutes until it becomes foamy. This step activates the yeast, which is necessary for fermentation.

Step6: **Adding Yeast to the Slurry**

Once the yeast is ready, add it to the cooled peel slurry and mix gently. Make sure the slurry is not too hot, as high temperatures can kill the yeast. The yeast will start fermenting the sugars in the slurry to produce ethanol and carbon dioxide.

Step7**: Setting Up Fermentation**

Pour the mixture into bottles or jars, leaving some space at the top. Cover the bottles with balloons or airlocks to trap the carbon dioxide gas produced during fermentation. Place the bottles in a warm place (around 25–30°C) and let them sit for 3–4 days. You will notice the balloons inflating as carbon dioxide is released, which is a sign that fermentation is happening.

Step8: **Monitoring Fermentation**

Check the bottles daily. Observe the balloon size, color of the slurry, and any bubbling or froth. These are signs that the yeast is active and converting sugars into ethanol. Record your observations carefully for later analysis.

Step9: **Filtering the Mixture**

After fermentation is complete, pour the mixture through filter paper or a clean cloth to separate the liquid ethanol from the solid residues. The filtered liquid contains ethanol along with some water and other substances.

Step10: **Optional Distillation**

If a distillation setup is available and supervised by a teacher or adult, the ethanol can be distilled to increase its purity. This step separates ethanol from water based on differences in boiling points.

Step11: **Storing the Ethanol**

Collect the filtered ethanol in a clean, dry container. Label it clearly and keep it away from open flames, as ethanol is highly flammable.

Step 12: **Recording Results**

Measure the volume of ethanol produced from each type of peel and note any differences.

Compare the yields from banana, potato, and orange peels to see which peel produces the most ethanol.

- Peel slurry
- Boiling step
- Balloon inflation during fermentation
- Filtration setup

Variables :

In any scientific experiment, it is important to understand the variables that can affect the results. Variables are factors that can change or be controlled to see how they influence the outcome of the experiment. In this project on producing bioethanol from fruit and vegetable peels, several variables were considered to ensure accurate and reliable results.

1. Independent Variable (What we change):

The independent variable is the type of fruit or vegetable peel used in the experiment. In this project, three types of peels were tested: banana, potato, and orange peels. Each type of peel has a different composition of starch, sugar, and fiber. By changing the type of peel, we can observe how it affects the amount of ethanol produced. This helps determine which peel is the most effective for bioethanol production.

2. Dependent Variable (What we measure):

The dependent variable is the amount of ethanol produced from each peel. This is measured in milliliters (ml) after fermentation and filtration. Other dependent observations include the rate of fermentation, which can be seen by the inflation of the balloon, the bubbling in the mixture, the smell of the fermented mixture, and the color change in the slurry. These observations indicate how active the yeast is and how effectively it converts sugars into ethanol.

3. Controlled Variables (What we keep the same):

To ensure a fair comparison between the different peels, certain factors must be kept constant:

Amount of peel used:

The same weight or volume of each peel is used to maintain consistency.

Amount of water:

The water-to-peel ratio is kept the same to ensure the mixture is similar for all types.

Amount of yeast:

The same quantity of yeast is added to each peel slurry to ensure uniform fermentation.

Temperature:

All samples are kept at the same temperature (around 25–30°C), as temperature affects yeast activity.

pH:

The acidity of each peel slurry is adjusted to the same range (4.5–5.0) to create optimal conditions for yeast fermentation.

Fermentation time:

Each peel slurry is left for the same duration (3–4 days) to allow sufficient time for ethanol production.

By controlling these factors, the experiment ensures that the differences in ethanol yield are due to the type of peel used, rather than other conditions.

4. Other Factors to Consider:

Some other factors may also influence the results, such as:

Freshness of the peels:

Fresher peels may have higher sugar content than older or slightly spoiled peels.

Size of cut pieces:

Smaller pieces allow better access for yeast, which can increase fermentation efficiency.

Mixing and aeration:

Proper mixing ensures that yeast spreads evenly throughout the slurry, helping fermentation.

Understanding these variables helps students analyze results accurately and learn about the scientific method.

By carefully controlling variables, we can determine that banana peels produce more ethanol than potato and orange peels due to their higher starch content.

IV. RESULTS:

After completing the fermentation process, the ethanol produced from banana, potato, and orange peels was measured and recorded. Observations showed that banana peels produced the highest ethanol yield, followed by potato peels, and orange peels produced the least. This result is consistent with the starch and sugar content of the peels. Banana peels, rich in carbohydrates, provided more fermentable sugars for the yeast, which resulted in a larger amount of ethanol. Potato peels also produced ethanol, but in slightly smaller quantities due to slightly lower starch content. Orange peels, with higher fiber content and less starch, produced the least ethanol.

The volume of ethanol collected from each peel after filtration (and optional distillation) was approximately: Banana peel: 8 ml

- Potato peel: 6 ml
- Orange peel: 3 ml

These measurements demonstrate that the type of peel significantly affects ethanol yield. The activity of yeast, observed through balloon inflation, bubbling, and smell, also confirmed that banana peels had the most active.

Peel Type	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Balloon Size**	**Odor**	**Ethanol Yield (ml)**
Banana	**Bubbling begins**	**Increased bubbling**	**Balloon inflates**	**Fully inflated**	**Large**	**Mild fermente d**	**8**
Potato	**Few bubbles**	**Moderate bubbling**	**Balloon expands**	**Balloon moderate ly inflated**	**Medium**	**Mild fermente d**	**6**
Orange	**Minimal bubbles**	**Slight bubbling**	**Balloon slightly expands**	**Balloon small**	**Small**	Citrus smell	**3**

BIOETHANOL FROM BANANA, POTATO, AND ORANGE PEELS:

STEPS:

1. I collected banana peels, potato peels, and orange peels from the kitchen.
2. I washed the peels and cut them into small pieces.
3. I ground each peel separately by adding a little water to make a paste.
4. I boiled the paste for a few minutes and allowed it to cool.
5. I filtered the mixture and collected the liquid extract.
6. I added yeast to each extract and kept the mixtures for two to three days for fermentation.
7. I observed bubbles and smell changes during fermentation.
8. After fermentation, I heated the mixture to separate the ethanol by distillation.
9. I collected the distilled liquid, which is bioethanol.
10. I tested the bioethanol by burning a small amount to check the flame.

OBSERVATION

1. The banana peel mixture produced many bubbles during fermentation.
2. The potato peel mixture produced a moderate amount of bubbles.
3. The orange peel mixture produced fewer bubbles compared to the others.
4. After distillation, banana peel gave the highest amount of bioethanol.

5. The flame test showed that banana peel bioethanol burned strongly, potato peel bioethanol burned moderately, and orange peel bioethanol burned weakly.

6. All three peels produced a clear liquid after distillation.

Banana, potato, and orange peels can be used to produce bioethanol. Banana peels gave the best result among the three.

During the experiment, careful observation is very important to understand how the yeast converts sugars in the fruit and vegetable peels into ethanol. Observations were made daily over the 3–4 days of fermentation, noting changes in color, texture, smell, balloon inflation, and finally the volume of ethanol produced from each peel.

1. Banana Peels:

The banana peel slurry was thick and light brown after blending. On the first day, small bubbles appeared on the surface, and the balloon began to slowly inflate. By the second day, the bubbling increased, and the balloon was noticeably larger, indicating active fermentation. The slurry's color became slightly darker, and a faint fermented smell was detected. After 4 days, the balloon had fully inflated, and the liquid smelled like mild ethanol. Upon filtering, the ethanol yield from banana peels was the highest compared to the other peels.

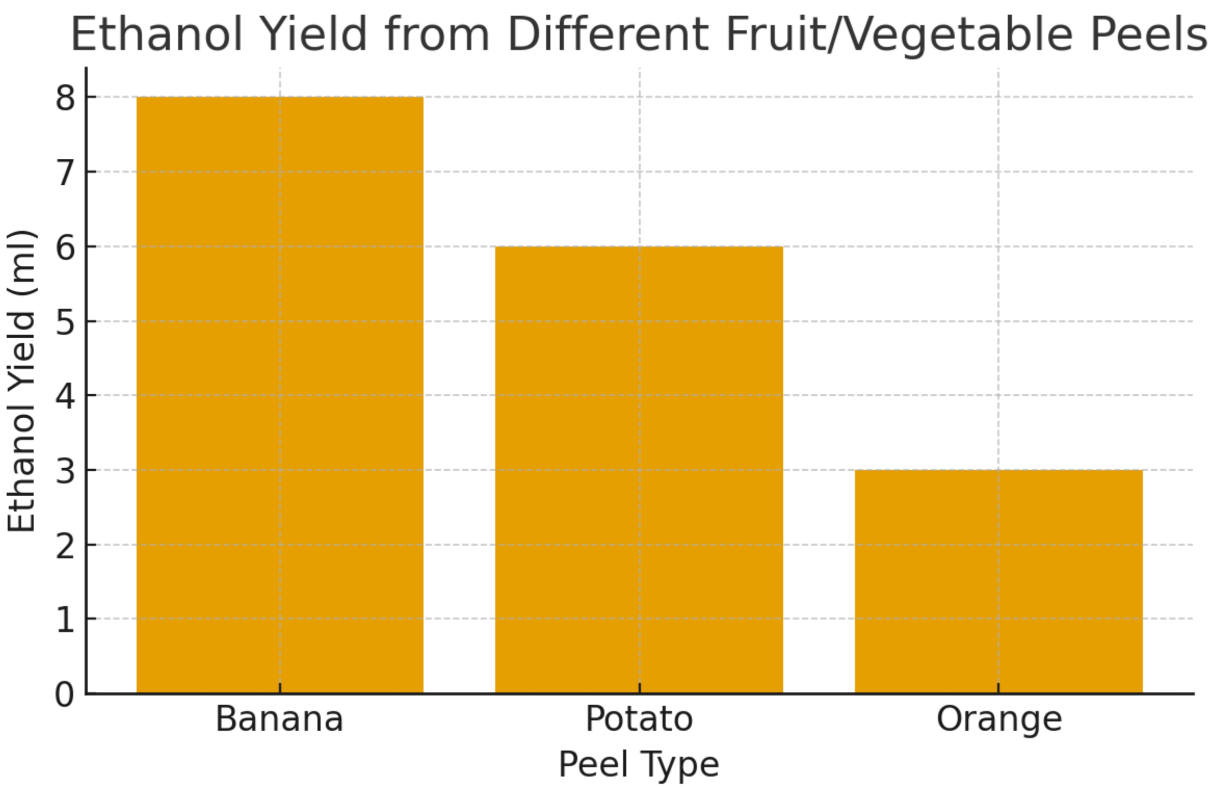
2. Potato Peels:

The potato peel slurry was slightly watery but still thick enough for fermentation. On the first day, very few bubbles were observed, and the balloon inflated slowly. By the second day, the bubbling increased slightly, and the balloon started to expand. The fermentation activity was slower than banana peels but steady. After 4 days, the balloon was moderately inflated, and a mild fermented smell was present. The filtered ethanol from potato peels was slightly less than that from banana peels, consistent with the starch content in the peels.

3. Orange Peels:

The orange peel slurry was watery and light in color. On the first day, very little bubbling was observed, and the balloon inflation was minimal. The mixture had a citrus smell, and fermentation activity was slower compared to banana and potato peels. By the third and fourth days, slight bubbling was noticed, and the balloon expanded a little. The ethanol yield from orange peels was the lowest among the three types, likely due to the lower starch content and higher fiber in orange peels.

BAR DIAGRAM:



Ethanol Yield from Different Fruit/Vegetable Peels
Ethanol Yield (ml)
0
1
2
3
4
5
6
7
8
Banana
Potato
Orange
Peel Type

V. DISCUSSION :

The result of this project provides several insights into bioethanol production from fruit and vegetable waste. First, the composition of the peel directly affects ethanol production. Peels rich in starch and sugar, like banana peels, provide more substrate for yeast, which increases ethanol yield. Fibrous peels like orange produce less ethanol because fiber is not easily fermented by yeast.

Second, the experiment highlights the importance of controlled conditions. Maintaining a warm temperature, proper pH, and correct yeast concentration ensured that fermentation proceeded efficiently. Any variation in these factors could have slowed down or stopped fermentation, resulting in lower ethanol yield.

Third, the project demonstrates that small-scale bioethanol production is feasible with simple materials and household waste. While the quantities produced in this experiment are small the principles can be applied to larger scales, showing the potential for sustainable energy production from organic waste.

This experiment also reinforces scientific learning and observation skills. Students observed the entire process of fermentation, from slurry preparation to ethanol collection, and learned how variables such as peel type, pH, and yeast affect results. Using visual indicators like balloon inflation helped students understand microbial activity and its role in energy production.

Furthermore, the project emphasizes the environmental benefits of using waste for energy. By converting banana, potato, and orange peels into ethanol, organic waste that would otherwise decompose and release methane is transformed into a useful fuel. This shows a practical approach to waste management and renewable energy generation.

Finally, the experiment encourages critical thinking. Students can analyze why certain peels produced more ethanol, consider ways to increase yield, and explore other organic materials that could serve as fuel sources. It also inspires innovative ideas for sustainable practices, energy conservation, and small-scale biofuel production.

The study demonstrates that banana, potato, and orange peels can be effectively utilized for bioethanol production, offering a sustainable solution for waste management and renewable energy. The varying bioethanol yields (banana > potato > orange) highlight the importance of feedstock selection and process optimization. This approach can contribute to reducing greenhouse gas emissions, mitigating waste disposal issues, and promoting a circular economy, with potential applications in rural development and energy diversification.

1. Feedstock selection: The choice of feedstock significantly impacts bioethanol yield. Banana peels, with their high starch content, produced the highest yield, followed by potato and orange peels.

2. Pretreatment methods: Different pretreatment methods can affect bioethanol yield and process efficiency.

3. Fermentation conditions: Optimizing fermentation conditions (e.g., temperature, pH, yeast strain) is crucial for maximizing bioethanol production.

4. Scalability: Scaling up bioethanol production from fruit and vegetable waste requires careful consideration of logistics, cost, and energy efficiency.

5. Waste management: Utilizing fruit and vegetable waste for bioethanol production can mitigate waste disposal issues and reduce environmental pollution.

6. Energy balance: The energy required for bioethanol production should be compared to the energy output to ensure a positive energy balance.

7. Economic viability: The economic feasibility of bioethanol production from fruit and vegetable waste depends on factors like feedstock cost, process efficiency, and market demand.

8. Co-product generation: The residue left over from bioethanol production can be used as animal feed or compost, adding value to the process.

VI. CONCLUSION:

The experiment on producing bioethanol from banana, potato, and orange peels successfully demonstrated how organic waste can be transformed into a renewable source of energy. The project showed that fruit and vegetable peels, which are often discarded as kitchen waste, contain carbohydrates and sugars that can be fermented by yeast to produce ethanol. Among the three types of peels, banana peels yielded the highest ethanol, followed by potato peels, and orange peels produced the least. This difference was mainly due to the starch and sugar content in each peel.

This project highlights the potential of small-scale bioethanol production as a sustainable and environmentally friendly solution. By using waste materials, we can reduce organic waste in landfills, lower greenhouse gas emissions, and create a clean-burning fuel. The experiment also emphasizes the importance of controlled conditions, such as temperature, pH, and yeast concentration, which directly affect the success of fermentation.

In addition to producing ethanol, the project provides valuable educational benefits. Students learn about fermentation, the role of microorganisms in energy production, and the principles of renewable energy. They also develop observation, recording, and analytical skills, which are important for scientific experiments.

Overall, this project demonstrates a practical approach to waste management, energy sustainability, and environmental awareness. It encourages innovative thinking and shows that simple, cost-effective solutions can have a meaningful impact on both local and global levels. By turning kitchen waste into bioethanol, we can contribute to a cleaner environment and promote the use of renewable energy in everyday life.

The results and discussion show that banana peels are the most efficient for ethanol production, followed by potato and orange peels. The experiment successfully demonstrates the process of bioethanol production from organic waste, highlights the importance of controlled conditions, and provides a hands-on understanding of fermentation, renewable energy, and sustainability.

Safety is an important consideration when performing any experiment, even when working with common household materials like fruit and vegetable peels. In the production of bioethanol, several risk factors must be considered to prevent accidents and ensure a safe learning environment.

1. Handling Hot Liquids:

During the procedure, the peel slurry is boiled to release sugars and kill harmful bacteria. Boiling water and slurry can cause burns or scalds if not handled carefully. It is important to use oven mitts, gloves, or tongs when moving hot containers. Always pour hot liquids slowly and carefully, and avoid leaning over the pot while boiling. Children should perform this step only under adult supervision.

2. Use of Acids for pH Adjustment:

To adjust the pH of the peel slurry, lemon juice or citric acid is added. While these are mild acids, they can still irritate the skin or eyes. It is important to wear gloves and goggles and avoid direct contact with the eyes. If any acid spills on the skin, wash immediately with plenty of water.

3. Yeast Handling:

Baker's yeast (Saccharomyces cerevisiae) is generally safe, but it is a living organism. Allergic reactions are rare but possible. Avoid inhaling dry yeast powder and wash hands after handling it. Always add yeast to the cooled slurry, as high temperatures can kill the yeast, wasting the experiment.

4. Carbon Dioxide Production:

During fermentation, yeast produces carbon dioxide gas, which inflates the balloons or airlocks. Although this gas is not toxic, it can cause pressure buildup if the container is sealed too tightly. Make sure bottles are not completely closed, and use balloons or airlocks that allow gas to escape safely. Over-inflated balloons should be removed carefully to prevent splashing of the fermenting mixture.

5. Handling Ethanol:

Ethanol is flammable, and even small amounts can catch fire if exposed to an open flame. During filtration or distillation, ensure there are no flames nearby. Use ethanol in a well-ventilated area and store it in a labeled container away from heat sources. Small-scale experiments can be done with diluted ethanol, reducing fire risk.

6. Waste Disposal:

The leftover peel slurry after filtration is organic waste. If disposed of improperly, it can attract pests or produce unpleasant odors. Composting the waste is recommended. Never pour ethanol down the drain in large amounts. Always follow safe and environmentally friendly disposal practices.

7. Distillation Risks (Optional Step):

If distillation is performed, extra care is needed. Distillation involves heating liquids to separate ethanol, which increases the risk of burns and fire. It should always be done under supervision by a teacher or experienced adult. Use proper glassware, clamps, and heat sources, and work in a safe, ventilated area.

8. General Laboratory Safety:

- Wear gloves, goggles, and aprons to protect the skin and eyes.
- Tie back long hair and avoid loose clothing near hot surfaces
- Keep first aid materials nearby in case of minor accidents.
- Wash hands thoroughly after the experiment.

Biofuels are gaining importance as a renewable energy source, especially in countries like India where reducing fossil fuel dependency is a priority. Fruits and vegetables like bananas, potatoes, and oranges generate a lot of waste in the form of peels. These peels, rich in sugars, can be converted into bioethanol through fermentation.

This project explores the production of bioethanol from banana, potato, and orange peels, aiming to tap into the potential of food waste for sustainable energy.

The production of bioethanol from fruit and vegetable peels has several important impacts, ranging from environmental benefits to educational and practical applications.

This project demonstrates how household waste can be transformed into a valuable energy resource, which can inspire students and communities to adopt more sustainable practices.

Before handling the raw materials (banana, potato, orange peels), wash hands with soap and water for at least 20 seconds, paying attention to areas between fingers, under nails, and the backs of hands.

This practice helps prevent the introduction of unwanted microorganisms that could affect fermentation or safety during the bioethanol production process.

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M. Humaira

Grade VI