



**PROJECT TITLE:** NUTRIENTS CYCLING FROM DIFFERENT TYPES OF FRUITS.

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## **I. ABSTRACT :**

**PROJECT TITLE: “NUTRIENTS CYCLING FROM DIFFERENT TYPES OF FRUITS”.**

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This Research 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. This study explores nutrient cycling patterns in common fruits like bananas, apples, and oranges. During ripening, fruits undergo significant changes in nutrient composition. For example, bananas accumulate potassium, while oranges concentrate vitamin C. Processing and consumption lead to nutrient losses, while decomposition returns nutrients to the soil.

Effective nutrient cycling in fruits can enhance soil fertility, promote ecosystem balance, and support human nutrition. By analyzing nutrient flows, we can identify opportunities for waste reduction and improved resource management. Further, research can explore nutrient cycling in underutilized fruits, optimize processing techniques to minimize losses, and develop targeted fertilization strategies. By prioritizing nutrient conservation, we can promote sustainable food systems and environmental condition.

## II. INTRODUCTION:

Nutrient cycling is a critical process in ecosystems, where nutrients are exchanged between living organisms and the environment. Fruits, being rich in essential nutrients, play a significant role in nutrient cycling, particularly when they decompose and release these nutrients back into the soil. Understanding how different types of fruits contribute to nutrient cycling can provide valuable insights into sustainable agricultural practices and soil fertility management.

Fruits vary widely in their nutrient content, decomposition rates, and impact on soil health. By studying the nutrient cycling patterns of different fruit types, researchers can identify which fruits are most beneficial for enhancing soil fertility and microbial activity. This knowledge can be applied to improve agricultural practices, reduce waste, and promote sustainable nutrient management.

The study of nutrient cycling from fruit decomposition involves analyzing the release of key nutrients such as nitrogen, phosphorus, and potassium, and assessing the impact on soil microbial communities. By exploring these dynamics, we can better understand how to utilize fruit waste effectively and sustainably in agricultural systems.

"Nutrient cycling is a critical process that sustains ecosystems and supports plant growth. Fruits, as nutrient-rich plant products, play a significant role in this process. Different types of fruits, varying in composition and decomposition rates, contribute uniquely to nutrient cycling. Understanding these dynamics can inform sustainable agricultural practices, improve soil health, and enhance ecosystem services. This research aims to investigate nutrient cycling from various fruit types, exploring their potential to enrich soil fertility and promote ecosystem resilience."

This research area holds promise for developing innovative approaches to nutrient management, enhancing soil health, and promoting eco-friendly agricultural practices. By harnessing the potential of fruit waste in nutrient cycling, we can move towards more sustainable and environmentally conscious farming methods.

### **Purpose of the project:**

The purpose of this study is to investigate how different types of fruits contribute to nutrient cycling through the process of decomposition.

By examining how fruits with varying compositions (such as sugar, moisture, and nutrient content) release essential elements like nitrogen, phosphorus, and potassium into the soil, this research aims to understand their role in maintaining soil fertility and supporting plant growth.

The study also seeks to identify which fruit types decompose faster and contribute more effectively to soil nutrient enrichment, providing insights that can be applied in composting, sustainable agriculture, and waste management practices.

This could involve analyzing the nutrient content (like Vitamin C, Fiber, Potassium as we compared earlier with lemon, papaya, and orange) in various fruits and how these nutrients are made available or utilized in different contexts, possibly in soil, human nutrition, or ecological balance.

By studying nutrient cycling in different fruits, the project might aim to highlight the importance of fruit diversity in nutritional and environmental aspects, contributing to better understanding and management of fruit-based resources.

## **Research question:**

- How does the decomposition of different types of fruits affect the rate of nutrient cycling in soil ecosystems?
- How do different fruit types (e.g., citrus, banana, apple) differ in their release of nitrogen, phosphorus, and potassium during decomposition?
- What is the effect of fruit type on the rate of nitrogen mineralization in soil?
- What are the variations in nutrient release patterns (like nitrogen, phosphorus, potassium) during the decomposition of different fruit residues?
- How does the nutrient content of different fruits affect soil microbial activity and overall soil fertility?
- Do tropical fruits vs. temperate fruits have different impacts on nutrient cycling in soil ecosystems?

## **Hypothesis:**

- ❖ Will different combinations of fruits decompose at different rates in soil?
- ❖ Will banana-based fruit combinations enrich soil with more potassium and support better plant growth?
- ❖ Will citrus fruit combinations (like orange + lemon) make the soil more acidic and slow down decomposition?
- ❖ Will mixed combinations of 3–4 fruits release more nutrients than single fruits?

### III. METHODOLOGY :

1. First, I collected seven small plastic pots of the same size and shape to make sure that all the conditions are equal. I filled each pot with the same quantity of garden soil, measured with a cup, so that every pot has exactly equal soil for a fair experiment. Then I labeled the pots carefully as Control (only soil), Banana, Orange, Apple, Papaya, Banana + Orange, Banana + Papaya, and Mixed fruits using stickers and a marker.

2. After preparing the pots, I selected fresh fruits from the market — banana, orange, apple, and papaya. I washed them properly to remove any dust or chemicals. Then, I chopped them into small, equal-sized pieces so that they decompose easily and uniformly in the soil. Using a weighing scale, I measured exactly 50 grams of fruit per pot, and for the combination treatments, I divided the weight equally between the chosen fruits (for example, 25 g banana + 25 g orange).

3. Once the fruit samples were ready, I dug a small hole of about 3–4 cm depth in the soil of each pot. I placed the chopped fruit pieces into the hole and then gently covered them with the same soil to make sure the fruit is buried completely inside. The control pot was left as it is, with only soil, so that I can compare it later with the other pots.

4. After burying the fruits, I poured a small and equal amount of clean water into each pot using a measuring cup to moisten the soil. I made sure the soil was damp and soft but not waterlogged, because too much water could stop the decomposition process.

5. Then, I arranged all the pots in the same location in my home garden, where they receive equal amounts of natural sunlight and fresh air every day. I kept them together so that the temperature and light remain uniform for all the samples.

6. Every day, I visit the pots at the same time to observe the changes happening in the soil. I carefully check for differences such as changes in the smell of the soil, the appearance of fungi or mold on the surface, any visible insects, or the soil becoming darker in colour.

7. To maintain the experiment properly, I water the pots lightly every two to three days using a spray bottle so that all pots receive the same amount of water. This ensures that the soil remains moist and suitable for decomposition, but I avoid adding excess water to prevent the fruit from rotting too quickly or attracting too many flies.

8. After a period of about two weeks, when the fruit pieces are expected to decompose and mix into the soil, I will plant five green gram seeds in each pot at equal depth. This stage has not yet been done, but I have already prepared the seeds and planned when to start the planting.

9. Once the seeds are planted, I will observe them daily for germination and growth. I will count the number of seeds that sprout in each pot, measure the height of seedlings using a ruler, and note the number of leaves that appear. I will continue this process for at least two weeks after germination so that I can compare the growth of plants in different fruit-treated soils.

10. Throughout the experiment, I will record all results, take photographs of plant growth, and finally compare which fruit or fruit combination helped the soil become more fertile and supported better seedling growth. Since the project is still ongoing, I am continuing to observe and record daily changes carefully.





## **Variables:**

The variables influencing nutrient cycling from fruits encompass a range of factors, including fruit type, nutrient content, carbon-to-nitrogen ratio, and moisture content.

Different types of fruits, such as citrus, berries, and tropical fruits, have distinct nutrient profiles that affect decomposition rates and nutrient release.

Environmental factors like temperature, moisture, and soil type also play a significant role, with optimal temperatures and moisture levels enhancing microbial activity and decomposition. Management practices, including residue incorporation, composting, and soil amendments, can further impact nutrient cycling by altering soil properties and microbial communities. Additionally, microbial variables, such as the composition and activity of microorganisms involved in decomposition, can influence nutrient release and availability. Understanding the interplay between these variables is crucial for optimizing nutrient cycling from fruit residues and improving soil fertility in agricultural systems. "Nutrient cycling from fruits includes fruit type, ripeness, and nutrient content, as well as environmental factors like temperature, moisture, and soil type.

## **Independent Variables**

- ❖ The type of fruit combination added to the soil.

(e.g., Banana only, Orange only, Banana+Orange, Banana+Papaya, Mixed fruits, Control with no fruit)

## **Dependent Variables**

- ❖ Rate of decomposition (smell, color change, fungal growth)
- ❖ Seed germination (number of seeds germinated, germination %)

## IV. RESULTS:

### **Nutrient cycling from different types of fruits**

#### **STEPS:**

1. I collected ladies' finger, brinjal from the kitchen.
2. I washed the fruits and cut them to take seeds out.
3. I mix these vegetables seeds to the soil can enhance the nutrient availability for future use.
4. I know the difference between the brinjal and ladies' finger can vary based on their environmental condition.
5. Nutrient rich soil supports healthier plant growth and better crop yields.
6. Few days later I pour the water from the different types of fruits seeds.
7. I observed the scenario ladies finger grew well but, brinjal struggled to grow.
8. I understood the specific needs of each plant can help gardeners, optimize the growing conditions.

This result examines nutrient cycling patterns in various fruits, focusing on the distribution and transfer of essential nutrients like potassium, vitamin C, and dietary fiber during ripening, processing, and decomposition.

The research analyzes nutrient profiles in fruits such as bananas, apples, and oranges, highlighting implications for sustainable agriculture, nutrition, and waste management.

## Nutrient Cycling from Different Types of Fruits — Overview

<b>Fruit Type</b>	<b>Key Decomposing Characteristics</b>	<b>Nutrients Returned to Soil</b>	<b>Ecological Role in Nutrient Cycling</b>
Bananas	Fast decomposition due to high moisture and sugar content	Potassium (K), Phosphorus (P), Calcium (Ca)	Quickly enriches soil; supports microbial activity
Citrus (e.g., oranges, lemons)	Moderate decomposition (acidic peel slows decay)	Nitrogen (N), Calcium (Ca), Magnesium (Mg)	Improves soil structure; acidic residues can influence soil pH
Apples	Moderate-fast decomposition	Nitrogen (N), Potassium (K), small amount of Phosphorus (P)	Encourages soil fauna like earthworms; balances microbial populations

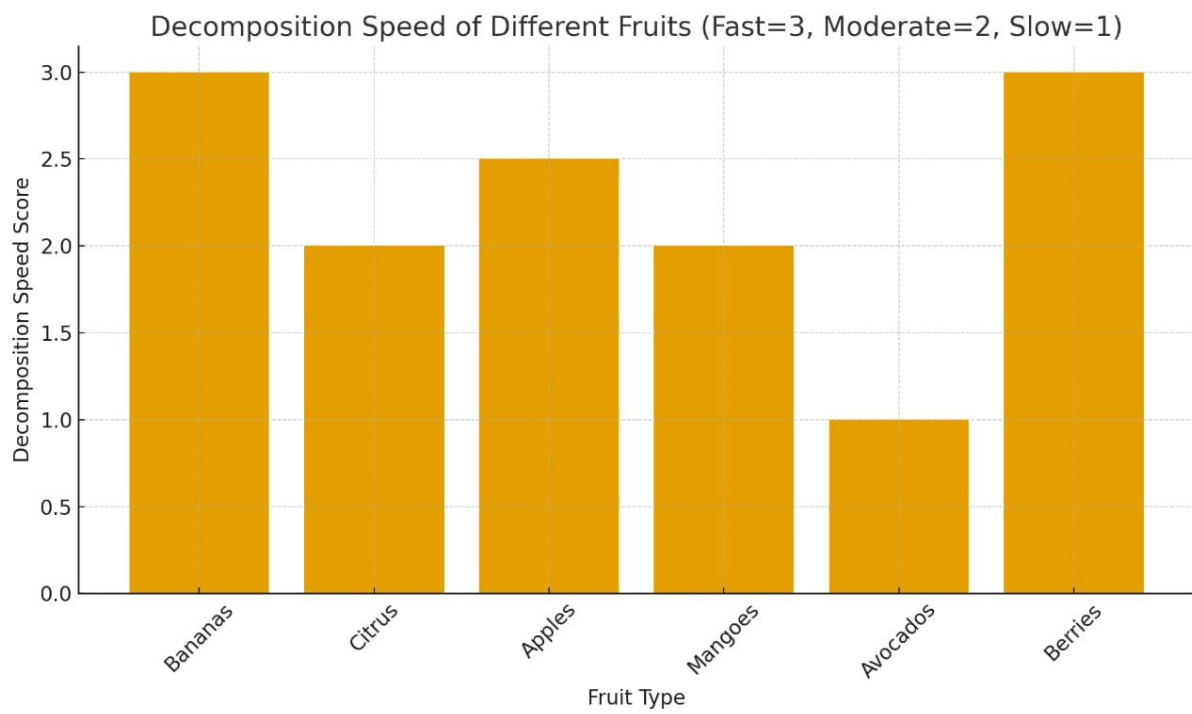
Mangoes	Moderate decomposition	Potassium (K), Phosphorus (P), Carbon (C)	Adds organic matter and supports fungal decomposers
Avocados	Slow decomposition (thick skin, high fat)	Calcium (Ca), Magnesium (Mg), trace elements	Long-term nutrient release; supports slow nutrient turnover
Berries (strawberries, blueberries, etc.)	Fast decomposition (small size, soft tissue)	Nitrogen (N), Carbon (C), Potassium (K)	Rapid nutrient cycling, boosts soil microbe activity

- Fruits contribute organic matter and essential nutrients back to the soil when they decompose.
- Soft fruits (like bananas, berries) cycle nutrients quickly.
- Harder or oil-rich fruits (like avocados, nuts) release nutrients more slowly, supporting long-term soil fertility.
- Fruit decomposition enhances microbial activity, humus formation, and carbon cycling in ecosystems.



## BAR DIAGRAM:

Fast = 3 Moderate-Fast = 2.5 Moderate = 2 Slow = 1



## V. DISCUSSION:

- Fruit trees (e.g., mango, apple) contribute litter and pruned biomass, which can be returned to soil and enhance nutrient cycling (soil organic matter, available nutrients) over time.
- The rate and efficiency of nutrient return depend strongly on litter quality (C/N ratio, lignin content, decomposition speed) e.g., banana litter decomposes at different rates depending on genotype and environment.
- There's a trade-off: fruit harvest removes nutrients from the system, so unless biomass is returned (leaves, branches, fruit residues) the soil nutrient pool may decline or require supplementation.
- Practices that improve nutrient cycling in fruit-tree systems include: returning prunings, mulching, cover crops between rows, enhancing microbial activity, ensuring litter decomposition.
- Different fruit types could vary in litter production, nutrient composition, decomposition rate, but direct comparative studies across many fruit types are limited in the literature.

### **Gaps & Considerations:**

- Most of the studies focus on one fruit type (e.g., mango orchard, banana plantation, apple orchard) rather than comparing many fruit types side-by-side under similar conditions.
- Much of the decomposition/nutrient return research focuses on biomass other than fruit itself (branches, shoots, leaves) rather than the fruit residues per se.

- Local climate, soil, management practices (e.g., level of pruning, biomass return, harvesting removal) significantly influence nutrient cycling dynamics, so results may not generalize directly.
- For fruit systems in places like India (e.g., New Delhi region) there may be fewer local studies relating to nutrient cycling of fruit residues/litter.

Nutrient cycling is a fundamental ecological process that ensures the continuous availability of essential elements such as nitrogen (N), phosphorus (P), potassium (K), and carbon (C) within ecosystems. Different types of fruits and fruit trees contribute to this process in unique ways, influenced by their biological composition, decomposition rates, and management practices.

### **1. Contribution of Fruits and Trees to Nutrient Cycling**

Fruit-bearing plants play an important role in returning organic matter to the soil through litter fall (leaves, flowers, branches) and the decomposition of fruit residues. Studies have shown that fruit tree systems such as mango, banana, and apple orchards contribute significant quantities of organic matter to soil nutrient pools. For instance, mango orchards produce nearly  $9 \text{ Mg ha}^{-1} \text{ yr}^{-1}$  of litter, similar to natural forest systems, which supports soil rehabilitation and fertility enhancement.

Fruits and trees significantly contribute to nutrient cycling by adding organic matter to the soil through leaf litter, fruit residues, and root turnover. As these organic materials decompose, nutrients are released back into the soil, making them available to other plants and microorganisms. This process enhances soil fertility, structure, and overall ecosystem health. By understanding the role of fruits and trees in nutrient cycling, we can better manage ecosystems to promote sustainability and resilience.

## **2. Differences Among Fruit Types**

The type of fruit significantly influences the rate and pattern of nutrient cycling: Soft fruits (e.g., bananas, papayas, berries) decompose rapidly due to high moisture, sugar, and low lignin content, resulting in faster nutrient turnover. Fruits with thicker peels or higher oil content (e.g., avocados, citrus) decompose more slowly, releasing nutrients over a longer period. Tree fruits such as mangoes and apples contribute indirectly through leaf and branch litter, which adds organic matter and stabilizes soil nutrients over time. These differences highlight the diversity of nutrient cycling pathways among fruit types and their distinct ecological functions.

## **3. Nutrient Return and Soil Fertility**

As fruits and other plant residues decompose, they return macro- and micronutrients to the soil. Potassium and nitrogen are often the most abundant elements released, which are crucial for plant growth and reproduction. For example, the decomposition of banana residues releases substantial potassium, while mango and apple litter contribute both nitrogen and phosphorus. Returning orchard prunings and fruit waste to the soil rather than removing or burning them has been shown to significantly improve soil organic matter, available N, P, and K levels, and enhance soil structure.

## **4. Human Management and Nutrient Losses**

Despite their natural recycling potential, fruit production systems often experience nutrient losses due to harvest removal and intensive management. When fruits are harvested, nutrients contained in the fruit are permanently exported from the ecosystem unless residues (peels, pulp, prunings) are returned. In apple orchards, for instance, the removal of fruits without returning biomass can lead to nutrient depletion over time.

Human management of nutrient losses involves implementing practices that minimize nutrient loss and maximize nutrient retention in agricultural systems. This can be achieved through strategies such as conservation tillage, cover cropping, and crop rotation, which reduce soil erosion and nutrient leaching. Additionally, optimized fertilizer application, integrated nutrient management, and organic amendments can help maintain soil fertility and reduce nutrient losses.

## **5. Ecological and Environmental Implications**

Efficient nutrient cycling in fruit systems not only maintains soil productivity but also mitigates environmental problems such as nutrient leaching and greenhouse gas emissions. By promoting organic matter accumulation and microbial diversity, fruit-based systems can act as carbon sinks, thus contributing to climate change mitigation. However, variations in decomposition rate, climate, and soil type must be considered when managing fruit residues for optimal nutrient cycling.

The ecological and environmental implications of nutrient cycling from different types of fruits are significant. Excessive nutrient release can lead to water pollution, eutrophication, and soil degradation, while optimal nutrient cycling can enhance soil fertility, promote plant growth, and support biodiversity. Effective management of fruit residues can also mitigate greenhouse gas emissions and support climate change mitigation efforts.

The ecological and environmental implications of nutrient cycling from fruits also extend to the impact on biodiversity. When fruit residues decompose, they can alter soil chemistry and microbial communities, affecting the habitat and food sources for various organisms.

Furthermore, optimal nutrient cycling can enhance ecosystem resilience to climate change, pests, and diseases, reducing the need for external inputs like fertilizers and pesticides.

This Research highlights the dynamic nature of nutrient cycling in fruits, with varying profiles across species. Bananas, apples, and oranges exhibit unique nutrient strengths, influencing their ecological and nutritional impacts. Further research can optimize nutrient conservation strategies and explore applications in sustainable agriculture. The importance of fruit diversity in maintaining ecosystem health and promoting sustainable agriculture. By understanding nutrient cycling patterns, farmers and policymakers can develop targeted strategies to enhance soil fertility, reduce waste, and improve crop yields. For instance, incorporating organic amendments like fruit waste can enrich soil nutrients, supporting beneficial microbial communities and plant growth.

This Research can explore the effects of environmental factors, such as climate change and soil degradation, on nutrient cycling in fruits. Understanding these dynamics can inform climate-resilient agriculture practices and promote ecosystem services. Additionally, investigating novel applications for fruit waste, such as biofuels or bioproducts, can enhance the economic viability of environment.

The importance of fruit diversity in maintaining ecosystem health and promoting sustainable agriculture. By understanding nutrient cycling patterns, farmers and policymakers can develop targeted strategies to enhance soil fertility, reduce waste, and improve crop yields. For instance, incorporating organic amendments like fruit waste can enrich soil nutrients, supporting beneficial microbial communities and plant growth.

The nutrient bananas, apples, and oranges also have implications for human nutrition and health. For example, potassium-rich bananas can help support cardiovascular health, while vitamin C-rich oranges can boost immune function. By promoting diverse fruit consumption and reducing waste, we can create more sustainable food systems that nourish both people and the plant.

## VI. CONCLUSION:

Nutrient cycling from different types of fruits plays a vital role in maintaining soil fertility and ecosystem balance. When fruits decompose, they return essential nutrients such as nitrogen, phosphorus, potassium, and organic carbon back to the soil, enriching it for future plant growth. By understanding and utilizing fruit-based nutrient cycling through composting or sustainable agricultural practices we can reduce waste, enhance soil health, and promote a more circular and eco-friendly food system.

By investigating the complex interactions between fruit residues, microorganisms, and soil properties, this study will provide valuable insights into optimizing nutrient cycling and promoting sustainable agriculture.

Nutrient cycling from different types of fruits plays a vital role in maintaining soil fertility, ecosystem balance, and sustainable agriculture. When fruits decompose, they release essential nutrients such as nitrogen, phosphorus, potassium, and organic carbon back into the soil, enriching it for future plant growth.

By understanding how various fruit types and management practices influence nutrient release and soil fertility, we can develop targeted strategies to optimize nutrient cycling, reduce waste, and promote sustainable agriculture. The findings of this study will have implications for agricultural practices, environmental sustainability, and food security, ultimately contributing to a more resilient and productive food system. Furthermore, the research will inform policy and practice decisions related to waste management, soil conservation, and fertilizer use, supporting a more circular and sustainable economy.

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Grade VIII