Formulation of Cost-Effective Banana and Potato Peel Media for Microbial Growth

A Research Project

Submitted by,

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DEPARTMENT OF MICROBIOLOGY

VIVEKANAND COLLEGE, KOLHAPUR

(AN EMPOWERED AUTONOMOUS INSTITUTE)

YEAR 2024-2025

"Dissemination of education for Knowledge, Science and culture"

- Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

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PG DEPARTMENT OF MICROBIOLOGY

CERTIFICATE

OF

RESEARCH PROJECT COMPLETION

This is to certify that Ms. **HARSHADA B. BODAKE** studying in M. Sc. part II Microbiology at Vivekanand College, Kolhapur (An Empowered Autonomous Institute) has sincerely completed research project work entitled **Formulation of Cost- Effective Banana and Potato peel media for Microbial growth** during academic year 2024-25.

Dr. Komal K. Bhise

Research Project Guide

Examiner

For

Dr. T. C. Gaupale

I/C HEAD
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This is to certify that Ms. **VAISHNAVI H. PATIL** studying in M. Sc. part II Microbiology at Vivekanand College, Kolhapur (An Empowered Autonomous Institute) has sincerely completed research project work entitled **Formulation of Cost- Effective Banana and Potato peel media for Microbial growth** during academic year 2024-25.

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This is to certify that Ms. **AKSHATA K. BUVA** studying in M. Sc. part II Microbiology at Vivekanand College, Kolhapur (An Empowered Autonomous Institute) has sincerely completed research project work entitled **Formulation of Cost- Effective Banana and Potato peel media for Microbial growth** during academic year 2024-25.

For

Dr. Komal K. Bhise | **Dr. T. C. Gaupale**

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Place: Kolhapur

Date: 05/05/2025

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INTRODUCTION

✞ INTRODUCTION

Waste management refers to the collection, transportation, processing, recycling or disposal, and monitoring of waste material. Its goal is to reduce the harmful effect of waste on human health and the environment. Banana peels, typically considered agricultural waste, are rich in nutrients and bioactive compounds that can be harnessed for various applications. (Lam,Y .F,Lee L.Y.2016)

This experiment explores the process of converting banana peels in powder by using drying and grinding techniques. The object is to investigate the potential uses of banana peel powder in food. Agriculture and industrial sectors, focusing on its nutritional value, antimicrobial properties and environmental benefits..Banana peels have good potential to be used as source of antioxidants in food *(Ode Ermawati, 2016)*.

The banana peel powder using the methods drying and grinding techniques, the powder resulting will then analyze for its composition, including its fiber contents, vitamins, minerals and antioxidant properties. Banana peels are organic waste that are highly reach in carbohydrate contain and other basic nutrients that support microbial growth. (Nazir, R. Nickel, J.2013)

Additionally, the study will access the antimicrobial effect of banana peel powder particularly its potential to inhibit the growth of harmful bacteria and fungi. Banana peel extracts can affect the pH balance and enzyme activity around microbes further preventing their growth. Banana peel extracts have shown in vitro antimicrobial activity against bacteria like *E. coli, Staphylococcus aureus*, and fungi such as *Candida albicans*. The environmental impact of utilizing banana peel powder will also be explored, particularly in reducing food waste and promoting sustainability. This aligns with global efforts to promote sustainability and minimize the environmental impact of organic waste. *(Ragab, G. H. & Ghanem, K. M. 2021)*

This project aims to contribute the devolvement of ecofriendly low-cost alternative for a variety of applications while also addressing global concern related to waste management and sustainability. As we explored formulation of banana peel medium, we also used potato peels for the comparison for antimicrobial activity. (PAVAN F.A.2008)

Potato peels have potential antimicrobial activity due to the presence of bioactive compounds such as phenolic acid, glycoalkaloids and flavonoids. These compounds can inhibit the growth of various bacteria and fungi, making potato peels a potential natural alternative in antimicrobial treatments. Potato peels are rich in fibers, vitamins like C, B, potassium, irons, magnesium. The potato peels are usually thrown as a waste but it can be used for the nutritional medium for the growth of bacteria and fungi. (Jacques R.A. 2008)

Potato peels are rich in carbohydrates, proteins, amino acids and minerals which make them suitable for supports the microbial growth. The starch present in potato peel provides carbon source while amino acids and minerals supports other cellular functions. Potato peels extract is cost-effective medium as compare to commercial nutrient media. It utilizes agro-waste, promoting waste recycling, reusing, or converting waste materials into resources. (Mohammed, R. Chomg M. F. 2014)

Potato peels used to culture fungi or bacteria in low- resource settings. Evaluating antimicrobial activity of natural extract by observing inhibition zones or microbial density changes. (E. C, Airoldi 2006)

Additionally, fruit wastes such as banana peel and potato peel waste were stabilized using anaerobic digestion. This process, enhanced by physical pretreatment like size reduction, improved biodegradability and increased methane yield during batch fermentation. Prehydrolysis under thermophilic conditions acted as a biological pretreatment, further stabilizing the digestion process. This was particularly effective under mesophilic conditions and with highsolid feedstock, leading to improved biogas production and overall organic matter destruction (Gushikem, Y.2006)

When improperly discarded in landfills, potato peels contribute to environmental problems such as methane emissions and poor waste management. However, by repurposing potato peel waste, these issues can be mitigated. This not only helps reduce environmental pollution but also promotes a circular economy, where waste is transformed into useful products. Such an approach supports global sustainability initiatives and helps minimize the ecological footprint of organic waste. (Gill R.Mahmood A. 2013)

Amylases were one of the first enzymes to be produced commercially by microorganisms. Amylases are amylolytic enzymes; represents a group of catalytic proteins of great importance in carbohydrate metabolism (M. Nagajan et al., 2010).

Amylase production has increased dramatically due to its wide spread use in food, textile, baking and detergent industries. Besides its use in the saccharification or liquification of starch, the enzyme is also used for the warp sizing of textile fibers, the clarification of haze formed in beer or fruits juices and for the pretreatment of animal feed to improve the digestibility. (Ibisi, N.E.2018)

Implications:

The findings of this study have broad implications, indicating that Potato peel waste can be transformed into valuable resources such as bioremediation agents. This transformation supports cost-effective waste disposal and contributes to sustainable development. According to Ragab and Ghanem (2021), potato peels serve as nutrient-rich substrates that promote microbial growth, offering an environmentally friendly solution for waste management and resource recovery. The study highlights the important role microorganisms can play in the degradation of organic waste, paving the way for more sustainable waste management practices. *(Ragab and Ghanem (2021)*,

Potato peel waste presents both challenges and opportunities, depending on its management:

Negative Implications:

1. Environmental Impact: Improper disposal in landfills leads to anaerobic decomposition and the release of methane, a potent greenhouse gas.
2. Waste Accumulation: High global consumption of bananas produces large quantities of waste, placing pressure on urban waste management systems.
3. Pest Problems: Improperly discarded potato peels can attract pests such as insects and rodents.

Positive Implications:

1. Agricultural Use: Potato peels are rich in nutrients like potassium, phosphorus, and calcium, making them effective as compost or direct soil amendments.
2. Sustainable Innovation: They are being researched as raw materials for bioplastics and biodegradable products.
3. Health Applications: In some cultures, potato peels are used in culinary and medicinal applications due to their antioxidant and anti-inflammatory properties.

Overall, while potato peel waste poses certain environmental risks, it also offers significant potential for sustainable resource utilization when properly managed.

The successful formulation of potato peel agar demonstrates the feasibility of using agricultural waste as a low-cost, sustainable alternative to conventional microbial growth media. Potato peels, rich in starch and nutrients, effectively supported the growth of various microorganisms, validating their potential as a base material for agar preparation. This approach not only reduces the cost of microbial culture media but also promotes environmental sustainability by repurposing food waste. Overall, potato peel agar offers a promising solution for laboratories and educational institutions seeking affordable and eco-friendly alternatives for microbial cultivation. (M. Nagajan et al., 2010).

Overall, potato peel showed promising potential as a new, low-cost, and eco-friendly agricultural waste material for oil spill cleanup. It not only reduces environmental contamination but also helps in managing agricultural waste effectively. Ragab and Ghanem (2021), Agro-industrial waste products such as banana and potato peels have gained attention as alternative, low-cost substrates for microbial culture media. This review evaluates and compares the efficacy of banana peel media (BPM) and potato peel media (PPM) for supporting microbial growth, focusing on nutrient composition, microbial compatibility, and sustainability.

The increasing demand for cost-effective and eco-friendly alternatives to conventional microbial culture media has prompted the use of organic waste materials. Banana and potato peels, rich in carbohydrates, proteins, and essential minerals, offer promising potential as media components for microbial culture in academic and industrial microbiology.

Potato peels offer numerous health benefits, including being a rich source of fiber, antioxidants, and various vitamins and minerals. They can help boost immunity, support digestive health, and potentially lower the risk of heart disease and cancer. Additionally, potato peels can be used in various applications like compost and even as a natural hair coloring agent.

Here's a more detailed look at the benefits:

➢ Nutritional Value:

- Fiber: Potato peels are a good source of dietary fiber, which aids digestion and promotes gut health.

- Vitamins and Minerals: They contain vitamin C, B vitamins (like B6 and folate), potassium, calcium, and magnesium, all of which are essential for various bodily functions.
- Antioxidants: Potato peels are rich in antioxidants like flavonoids, polyphenols, and anthocyanins, which protect the body against damage from free radicals and may help reduce the risk of chronic diseases.

  - Health Benefits:

- Immunity: The presence of vitamin C, calcium, and B vitamins in potato peels supports a healthy immune system.
- Heart Health: Potassium, found in abundance in potato peels, helps regulate blood pressure and reduce the risk of heart disease.
- Digestive Health: The fiber in potato peels promotes regular bowel movements and can help prevent constipation.
- Cancer Prevention: Some compounds in potato peels, like phytochemicals and chlorogenic acid, have been linked to cancer prevention.

  - Other Uses:

- Composting: Potato peels can be added to a compost bin to create nutrient-rich soil for gardening.
- Natural Hair Coloring: The juice of boiled potato peels can be used as a natural hair coloring agent.

Detailed Information for Study and Industrial Applications:

1. Composition and Properties:

- Dietary Fiber: Potato peels are a good source of dietary fiber, including both soluble and insoluble forms.
- Phenolic Compounds: They contain various polyphenols and phenolic acids, which contribute to their antioxidant properties.
- Starch: Potato peels also contain starch, though the content of fermentable reducing sugar is limited. • Other Components: They also contain proteins, lipids, and ash.

2. Nutritional and Health Benefits:

- Antioxidant Activity: Potato peel extracts have shown strong antioxidant properties, comparable to synthetic antioxidants like BHA and BHT.
- Antimicrobial Activity: Potato peel extracts have demonstrated antimicrobial activity against various bacteria and fungi, including Propionibacterium, gram-positive and gramnegative bacteria, and Candida albicans.
- Other Bioactive Compounds: They may contain other bioactive compounds with potential health benefits.

3. Industrial Applications:

Food Industry:

- Natural Preservatives: Potato peel extracts can be used as natural preservatives in food products due to their antioxidant and antimicrobial properties.
- Fiber Enrichment: Potato peel powder can be used as a source of dietary fiber in bread and other baked goods.
- Active Food Packaging: Potato peel extracts can be incorporated into food packaging materials to enhance their antimicrobial and antioxidant properties.

Other Industries:

- Biofuel Production: The high cellulose content of potato peels makes them a potential source of renewable energy.
- Papermaking and Textile Production: Potato peels can be used as a raw material in these industries.

4. Microbial Considerations:

- Fermentation: While potato peels contain starch, the fermentable sugar content is limited, requiring pre-treatment (e.g., hydrolysis) for fermentation.

- Antimicrobial Activity: Potato peel extracts have shown antimicrobial activity, which can be utilized in food preservation and other applications.
- Microbial Growth Inhibition: Studies have demonstrated that potato peel extracts can inhibit the growth of various microorganisms, including bacteria and fungi.

5. Research Areas:

- Optimizing extraction methods for bioactive compounds: Research is ongoing to find efficient ways to extract and isolate bioactive compounds from potato peels.
- Developing new applications for potato peel powder and extracts: Researchers are exploring innovative uses of potato peel in various industries.
- Investigating the mechanisms of action of bioactive compounds: Understanding how bioactive compounds in potato peels exert their effects is an ongoing area of research.

Banana Peel Agar (BPA) and Potato Peel Agar (PPA) are low-cost, eco-friendly alternatives made from kitchen waste, ideal for cultivating fungi and some bacteria.

BPA is rich in sugars and vitamins, supporting fungal and limited bacterial growth.

PPA is starch-rich, making it excellent for fungal/mycelial growth, especially in mushroom cultivation.

Nutrient Agar (NA) is a standardized, commercial medium that supports a wide range of bacterial and fungal growth, offering high consistency and reliability.

BPA and PPA are sustainable and economical but less consistent than NA, which is more precise but costlier and less environmentally friendly.

REVIEW OF LITERATURE

✟ REVIEW OF LITERATURE:

The development of alternative and cost-effective media for microbial culture has gained increasing attention in recent years. Traditional culture media like nutrient agar and potato dextrose agar (PDA) are widely used but can be expensive, particularly in resource-limited settings. In this context, agro-industrial waste materials such as potato peels have emerged as promising substrates due to their rich nutrient content and accessibility.

Nutritional Composition of Potato Peels:

Potato peels, a by-product of the potato processing industry, are rich in starch, cellulose, hemicellulose, proteins, vitamins, and minerals. These components can support microbial growth, making potato peels an ideal base for formulating alternative growth media. (Singh et al, 2010).

Development of Potato Peel Agar (PPA):

Several studies have reported the successful preparation and use of potato peel agar as a culture medium. PPA was found to effectively support the growth of both bacterial and fungal species, showing comparable performance to nutrient agar and PDA. Their study demonstrated that microorganisms such as Escherichia coli, Bacillus subtilis, and Aspergillus niger grew efficiently on PPA. (Sharma and Bhardwaj (2017), Comparative Studies:

the growth rate and colony morphology of selected microbes on PPA were nearly identical to those observed on standard media. The study also emphasized the environmental benefits of utilizing kitchen waste in microbiological practices. (Research by Rani et al. (2019) Sustainability and Cost Efficiency:

The use of PPA not only reduces laboratory costs but also promotes waste management and sustainability. the cost of preparing PPA was significantly lower than that of PDA, making it particularly useful for educational institutions and small-scale laboratories. (According to Verma et al. (2020)

Limitations and Future Prospects:

While promising, the use of PPA may have limitations in terms of reproducibility and shelf life. Further optimization, such as pH adjustment and supplementation with additional nutrients, may enhance its applicability. Future research could explore the use of other food wastes in combination with potato peels for improved microbial media.

Application:

The formulation of a potato peel agar (PPA) medium aims to utilize agro-industrial waste specifically potato peels as a sustainable, cost-effective alternative to conventional culture media (e.g., Nutrient Agar, Potato Dextrose Agar) for the cultivation of various microorganisms.

This approach supports the development of eco-friendly practices in microbiology by:

1. Reducing reliance on expensive, commercially prepared media.
2. Minimizing laboratory waste and promoting circular economy models
3. Enabling the growth and isolation of bacteria, fungi, and yeasts from environmental, clinical, or industrial samples
4. Providing a viable culture medium for educational institutions and lowresource laboratories

Applications in Research and Industry:

1. **Microbial screening:** For isolating bacteria or fungi from soil, water, food, and clinical samples.
2. **Biotechnology:** In fermentation processes where cost-effective culture media are essential.
3. **Environmental microbiology:** Monitoring and isolating biodegrades in composting or bioremediation studies.
4. **Food microbiology:** Evaluating microbial contamination or probiotic viability in processed or raw foods.
5. **Education:** As an affordable alternative for student experiments in microbiology labs.
6. **Sustainable practices:** Contributing to green lab initiatives by reducing synthetic inputs and reusing organic waste.

Nutritional Composition:

Banana peels are known to contain high levels of carbohydrates (mainly starch and simple sugars), potassium, and polyphenols, which can act as both growth-promoting agents and antimicrobial compounds. Potato peels, on the other hand, are rich in starch and contain glycoalkaloids, which can influence microbial growth depending on concentration and processing.

Microbial Growth Efficiency

Several studies have demonstrated that both BPM and PPM can support the growth of bacteria (e.g., E. coli, Bacillus subtilis) and fungi (e.g., Aspergillus Niger, Saccharomyces cerevisiae). However, BPM often shows superior performance in terms of biomass yield and growth rate, likely due to its higher sugar content and better mineral profile. PPM can be more variable depending on potato type and processing method.

Preparation and Cost

Both media are relatively easy to prepare through boiling or enzymatic hydrolysis, followed by sterilization. Banana peels may require additional treatment to remove inhibitory compounds for sensitive microbes. Nevertheless, both offer a significant cost advantage over commercial media like nutrient broth or potato dextrose agar.

Environmental and Economic Impact

Utilizing peels as media contributes to waste reduction, valorization of agricultural byproducts, and reduced reliance on synthetic chemicals. This aligns with the principles of green microbiology and circular bioeconomy.

1. Nutrient-rich ingredients: Banana peel powder and potato peel powder are rich in essential nutrients like fiber, antioxidants, and minerals.

2. Versatile applications: These powders can be used in various industries, including food, animal feed, and cosmetics.

3. Sustainable benefits: Utilizing these powders can help reduce waste, promote eco-friendliness, and support sustainable practices.

Benefits

1. Promotes health: The nutrient-rich composition of these powders can contribute to overall health and well-being.

2. Supports sustainability: By utilizing these powders, we can reduce waste and promote ecofriendly practices.

3. Innovative products: These powders can be used to create innovative products that benefit both humans and the environment.

Future Directions

1. Further research: Continued research on the properties and applications of banana peel powder and potato peel powder can unlock new opportunities.

2. Product development: Developing new products that incorporate these powders can help promote sustainability and health.

3. Industry adoption: Widespread adoption of these powders in various industries can contribute to a more sustainable future.

- **Banana peel media and nutrient agar media compaires microbial growth:**

1. Nutrient availability: Banana peel media and nutrient agar media differ in their nutrient composition. Nutrient agar is a standardized medium containing known amounts of nutrients, whereas banana peel media's nutrient content varies depending on the peel's composition.

2. Microbial growth: Both media can support microbial growth, but the type and rate of growth may differ due to variations in nutrient availability and other factors.

Comparison:

➢ **Nutrient Agar Media:**

1. Standardized nutrient composition: Nutrient agar contains a known amount of nutrients, ensuring consistent microbial growth.
2. Wide range of microbial growth: Nutrient agar supports the growth of a b2. road range of microorganisms.

3. Easy to prepare: Nutrient agar is a commercially available medium that is easy to prepare.

➢ **Banana Peel Media:**

1. Variable nutrient composition: Banana peel media's nutrient content varies depending on the peel's composition, which may affect microbial growth.
2. Cost-effective: Banana peel media is a low-cost alternative to traditional media.
3. Sustainable: Using banana peels as a growth medium can reduce waste and promote sustainability.

➢ **Microbial Growth:**

1. Type of microorganisms: Different microorganisms may grow better on one medium versus the other, depending on their nutritional requirements.
2. Growth rate: Microbial growth rates may vary between the two media due to differences in nutrient availability.

➢ **Advantages of Banana Peel Media:**

1. Low cost: Banana peel media is a cost-effective alternative to traditional media.
2. Sustainable: Using banana peels reduces waste and promotes sustainability.
3. Potential for novel discoveries: Banana peel media may support the growth of unique microorganisms.

➢ **Disadvantages of Banana Peel Media:**

1. Variable nutrient composition: The variable nutrient content may affect microbial growth and consistency.
2. Limited control: It's challenging to control the nutrient composition of banana peel media.

• **Potato peel media and nutrient agar media compares microbial growth:**

1. Both potato peel media and nutrient agar media can support microbial growth.
2. Both media provide nutrients for microorganisms to grow.

Differences:

➢ **Nutrient Agar Media:**

1. Standardized nutrient composition: Nutrient agar contains a known amount of nutrients, ensuring consistent microbial growth.
2. Wide range of microbial growth: Nutrient agar supports the growth of a broad range of microorganisms.
3. Easy to prepare: Nutrient agar is a commercially available medium that is easy to prepare.

➢ **Potato Peel Media:**

1. Variable nutrient composition: Potato peel media's nutrient content varies depending on the peel's composition, which may affect microbial growth.
2. Cost-effective: Potato peel media is a low-cost alternative to traditional media.
3. Sustainable: Using potato peels as a growth medium can reduce waste and promote sustainability.

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➢ **Disadvantages of Potato Peel Media:**

1. Variable nutrient composition: The variable nutrient content may affect microbial growth and consistency.
2. Limited control: It's challenging to control the nutrient composition of potato peel media.

- **Banana peel powder dried process:**
  - Banana peel was collected.
  - Simultaneously, banana peel was dried at sundry for 15 days.
  - After drying was done. After dried banana peels was grinded.
  - To forms banana peel powder.
  - This powder was stored in air dried bottle and labelled as banana peel waste media.

- **Potato peel powder dried process:**
  - Potato peel was collected.
  - Simultaneously, potato peel was dried at sundry for 15 days.
  - After drying was done. After dried potato peels was grinded.
  - To forms potato peel powder.
  - This powder was stored in air dried bottle and labelled as potato peel waste media.

- **Banana peel powder texture:**

Banana peel powder typically has a fine to medium texture, depending on the grinding process. The powder can range from a smooth, silky texture to a slightly coarser texture, depending on the desired consistency. The texture of banana peel powder can affect its uses in various applications, such as food, cosmetics, or animal feed.

- **Potato peel powder texture:**

Potato peel powder typically has a fine to medium texture, often slightly gritty or earthy due to the natural fiber content. The texture can vary depending on the grinding process and the potato variety used. Generally, the powder is smooth enough to be used in food, cosmetics, or animal feed applications, but it may retain some slight texture from the potato peels.

Amylase Production:

Amylases were one of the first enzymes to be produced commercially by microorganisms. Amylases are amylolytic enzymes; represents a group of catalytic proteins of great importance in carbohydrate metabolism (M. Nagajan et al., 2010).

Amylase production has increased dramatically due to its wide spread use in food, textile, baking and detergent industries. Besides its use in the saccharification or liquification of starch, the enzyme is also used for the warp sizing of textile fibers, the clarification of haze formed in beer or fruits juices and for the pretreatment of animal feed to improve the digestibility (M. Nagajan et al., 2010)

1. Microbial growth: Microorganisms such as bacteria and fungi can grow on potato peels and banana peel waste, utilizing the starches present in these substrates.

2. Amylase activity: These microorganisms can produce amylase enzymes, which break down starches into simpler sugars.

- **Advantages:**

1. Cost-effective: Using potato peels and banana peel waste as substrates can be a cost-effective way to produce amylase enzymes.

2. Sustainable: Utilizing waste materials reduces waste disposal costs and promotes sustainability.

3. Potential for industrial applications: Amylase enzymes produced using potato peels and banana peel waste can be used in various industries, such as food, textiles, and paper.

- **Microorganisms:**

1. Bacillus species: Known to produce amylase enzymes and can grow on potato peels and banana peel waste.

2. Aspergillus species: Fungi that can produce amylase enzymes and utilize starch-rich substrates like potato peels and banana peel waste.

- **Optimization:**

1. Substrate concentration: Optimizing the concentration of potato peels and banana peel waste can enhance amylase production.

2. pH and temperature: Controlling pH and temperature conditions can optimize microbial growth and amylase production.

3. Incubation time: Determining the optimal incubation time can ensure maximum amylase production.

➢ **Potential Applications**:

1. Food industry: Amylase enzymes can be used in food processing, such as in the production of glucose syrups and bread.

2. Textile industry: Amylase enzymes can be used for designing textiles.

3. Paper industry: Amylase enzymes can be used for starch degradation in paper production.

Comparison of Banana Peel Powder Media and Nutrient Agar Media Price:

➢ Banana Peel Powder Media:

The cost of banana peel powder can vary depending on the supplier and location, but it's generally cheaper than nutrient agar. Prices range from ₹80 to ₹180 per kilogram.

- Nutrient Agar Media:

Nutrient agar is more expensive, with prices starting from ₹3,250 per kilogram for Hi Media M001 500gm.

Composition: ➢ Banana Peel Powder Media:

Made from dried and powdered banana peels, rich in nutrients like potassium, phosphorus, and other essential micronutrients.

- Nutrient Agar Media:

A commercially available medium containing a balanced mix of nutrients, including peptone, beef extract, sodium chloride, and agar.

Uses: ➢ Banana Peel Powder

Media:

Can be used as an alternative medium for microbial growth, particularly for fungi and bacteria. It's a cost-effective option for research and industrial applications.

- Nutrient Agar Media:

  Widely used in microbiology laboratories for culturing a broad range of microorganisms, including bacteria and fungi.

Advantages:

• Banana Peel Powder Media:

- Cost-effective
- Sustainable
- Can promote characteristic reproductive structures in fungi, aiding identification • Nutrient Agar Media:
- nutrient composition
- Supports growth of a wide range of microorganisms
- Standardized Easy to prepare and use

Disadvantages:

• Banana Peel Powder Media:

- Variable nutrient composition
- May require optimization for specific microorganisms

• Nutrient Agar Media:

- More expensive than banana peel powder media
- May not be suitable for specific microorganisms with unique nutritional requirements[1 2]

Comparison of Potato Peel Powder Media and Nutrient Agar Media Price

- Potato Peel Powder Media:

The cost of potato dextrose agar (PDA), which utilizes potato infusion and dextrose, can vary depending on the supplier and location. However, it's generally cheaper than nutrient agar, with prices starting from around ₹325 for 500g.

- Nutrient Agar Media:

Nutrient agar is more expensive, with prices starting from ₹3,250 for 500g of Hi Media M001.

Composition:

- Potato Peel Powder Media:

  Made from potato infusion, dextrose, and agar, providing a nutrient-rich environment for microbial growth.
- Nutrient Agar Media:

  A balanced mix of nutrients, including peptone, beef extract, sodium chloride, and agar, supporting the growth of a wide range of microorganisms.

Uses: ➢ Potato Peel Powder

  Commonly used for culturing fungi, especially plant pathogens, and other microorganisms that thrive in nutrient-rich environments.
- Nutrient Agar Media:

  Widely used in microbiology laboratories for general-purpose culturing of bacteria, fungi, and other microorganisms.

Advantages:

- Potato Peel Powder Media:

Supports luxuriant growth of fungi and other microorganisms
Can be used for specific applications like plant pathogen cultivation

- Nutrient Agar Media:

Supports growth of a wide range of microorganisms

Provides a standardized nutrient composition

Disadvantages:

- Potato Peel Powder Media:

May not support growth of all types of microorganisms
Can be variable in composition depending on the potato infusion

➢ Nutrient Agar Media:

More expensive than potato peel powder media

May not be suitable for specific microorganisms with unique nutritional requirements[1]

• Types of Banana Peel Waste:

1. Fresh Banana Peels: Raw peels generated during banana consumption, processing, or handling.

2. Dried Banana Peels: Dehydrated peels that can be stored for longer periods and used for various applications.

3. Processed Banana Peels: Peels that have been processed into products like banana peel powder, extracts, or bioactive compounds.

4. Organic Banana Peels: Peels generated from organic banana farming or processing, free from synthetic chemicals and pesticides.

5. Industrial Banana Peels: Large quantities of peels generated during industrial banana processing, such as in the production of banana chips, puree, or juice.

Classification Based on Utilization:

1. Compost-grade Banana Peels: Peels used for composting, providing nutrients for soil amendment.

2. Animal Feed-grade Banana Peels: Peels used as animal feed, particularly for livestock.

3. Industrial-grade Banana Peels: Peels used for industrial applications, such as biofuel production, bioproducts, or biochemicals.

Classification Based on Moisture Content:

1. Wet Banana Peels: Fresh peels with high moisture content, requiring proper handling and storage.

2. Dry Banana Peels: Dehydrated peels with low moisture content, suitable for storage and transportation.

Other Types:

1. Green Banana Peels: Peels from unripe bananas, which may have different properties and uses.

2. Ripe Banana Peels: Peels from ripe bananas, which may be more suitable for certain applications.

- **Types of Potato Peel Waste**

1. Fresh Potato Peels: Raw peels generated during potato processing, cooking, or consumption.
2. Dried Potato Peels: Dehydrated peels that can be stored for longer periods and used as animal feed or other applications.
3. Processed Potato Peels: Peels that have been processed into various products, such as potato peel powder, flour, or extracts.
4. Organic Potato Peels: Peels generated from organic potato farming or processing, free from synthetic chemicals and pesticides.
5. Industrial Potato Peels: Large quantities of peels generated during industrial potato processing, such as in the production of potato chips, fries, or starch.

Classification Based on Utilization:

1. Feed-grade Potato Peels: Peels used as animal feed, particularly for livestock.
2. Compost-grade Potato Peels: Peels used for composting, providing nutrients for soil amendment.
3. Industrial-grade Potato Peels: Peels used for industrial applications, such as biofuel production, bioproducts, or biochemicals.

Classification Based on Moisture Content;

1. Wet Potato Peels: Fresh peels with high moisture content, requiring proper handling and storage.
2. Dry Potato Peels: Dehydrated peels with low moisture content, suitable for storage and transportation.

MATERIAL AND METHODS

✞ MATERIAL AND METHODS:

Methodology:

The Methodology of utilizing banana peel waste depend upon the specific applications or purpose such as composting, biofuel production, water purification or creating biodegradable materials.

✞ BANANA PEEL AGAR (BPA)

Preparation of Banana peel media:

- Collected banana peels are cleaned and grinded into paste
- Boil the paste for 10 to 15 min
- Filtered the mixture using filter paper / Whatman paper.
- Addition of agar-agar for the semi solid consistency
- Sterilized the mixture using autoclave.
- After sterilization the pouring of plate is performed.

Spreading and incubating the plates:

- Used the different concentrations of soil dilution suspensions on agar plates.
- Incubate the plates at 37 degree Celsius for 24 to 48 hrs.

Gram Staining and Motility:

- by taking well isolated colony suspension performed Gram staining and motility.
- Results are noted.

According to the previous research we discover the formulation of nutritious, lowcost media from the Banana peel waste for the Microbial growth. We isolate the organisms using the soil from the waste discarding area. That isolated organism s further tested for Gram nature and discovered as they are mostly Gram-Positive in Nature.

But we faced some kind of contamination by using the Banna peel Paste cause of paste's high moisture content so now we us the Banana peel powder

.

✞ Banana Peel Powder (BPP)

Media preparation and procedure:

Material Needed:

- Fresh banana peels powder.
- Soil (soil dilution)
- pH strips
- Agar-agar powder
- Distilled water, micropipettes.
- Grinder
- Measuring tools (Beakers, weighing scale, cylinders) • Sterile containers: (Petri plates, flasks, Sterile tips).

Banana peel powder process:

- Collected banana peel from household, chips making industries waste.
- Dried peels in hot air oven.
- Made a powder by using grinder

Benefits of using Banana Peel Powder:

1. Making banana peel powder increase the shelf life.
2. can stored easily and transport.
3. Also, powder can be less contaminated compare to the paste cause of less moisture content.
4. Powder is dry and less prone to microbial spoilage.
5. Can measure and mix powder more precisely in formulation or media.

6. Drying the peel concentrates nutrients in the powder, making it more potent per gram.

- **Preparation of Banana peel powder media:**

✞ For 1% banana peel powder media

Preparation:

We have used 1 gram of fresh Banana peel powder per 100 ml of distilled water to make 1% concentration.

Procedure:

We use 1gram of banana peel powder and add 2.5 gm Agar-Agar powder in 100ml dist water. Then we mixed well using glass rod and then autoclave it. Then sterilize media by autoclaving at 121 degree C for 15-20 minutes at 15 psi pressure.

After sterilization we prepared the plates and allowed them solidified the media. Took the 100 uL of soil diluted suspension and spreader on different plates respectively (labelled). Then incubates the plates upside down at 37 degree C for 24 to 48 hours.

✞ For 2% banana peel powder media:

Preparation:

Used 2 grams of fresh Banana peel powder per 100 ml of distilled water to make 2% concentration.

Observation:

After incubation well isolated colonies are observed and take one of the colonies.

✞ For 5% banana peel powder media:

Preparation:

Used 5 grams of fresh Banana peel powder per 100 ml of distilled water to make 5% concentration.

Observation:

After incubation well isolated colonies are observed and take one of the colonies.

We discovered the same kind of Growth on the Banana peel powder media but with less contamination. We study microbes involved in waste degradation. Then we observe colonies, color, texture and growth pattern.

Banana peel powder typically has a fine to medium texture, depending on the grinding process. The powder can range from a smooth, silky texture to a slightly coarser texture, depending on the desired consistency. The texture of banana peel powder can affect its uses in various applications, such as food, cosmetics, or animal feed.

✞ POTATO PEEL MEDIA (PPA)

1. **Collection of Potato peels –**
    - we gathered Potato peels from households, markets or food industries.
    - Separated the peels from other waste materials to ensure purity.

2. **Preparation of Potato peels-**
    - **Cleaning:** Washed the peels to remove dirt, pesticides or contaminants.
    - **Grinding:** For certain applications peels can be grounded into paste.
    - **media preparation:** we used potato peel waste refers to creating nutrient-rich growth medium for cultivation of micro-organism.

3. **Sterilization and soil dilution:**
    - **Sterilization**: To remove contaminants, ensure purity, improve safety, enhance stability sterilization has done by autoclaving method of sterilization.
    - **Soil dilution:** Soil collected from place of waste discarded area. Used welldrained soil with a neutral pH (6.0 – 7.5 is ideal for most bacteria).
    - Remove debris, stones, or large clumps for even mixing.
    - **Dilution ratios:** The organic material-to-soil ratio generally ranges from 1:4 to 1:10 (1 part of organic matter to 4 to10 part of soil).

4. **Pouring and spreading:**
    - **Agar pouring**: Agar pouring is the process of preparing and pouring agar-based media into Petri dishes to culture micro-organisms.
    - **Spreading**: This method ensures even distributers of diluted soil suspensions on agar plates to promote the growth of distinct microbial colonies for analysis.

5. **Incubation and count colonies:**

- **Incubation:** To provide optimal conditions for microbial growth so colonies can form from individuals' micro-organisms.
- Incubate plates upside down (agar side up) to prevent condensation from dripping onto the colonies at 37 degree C for 24 to 48 hours.
- **Colony counts**: To estimate the microbial population in the original soil sample based on colony forming units (CFUs).

Media preparation and procedure:

Material Needed:

- Fresh Potato peels (Potato peel paste),
- Soil (soil dilution)
- pH strips
- Agar-agar powder
- Distilled water, glass funnel, micropipettes.
- Grinder
- Measuring tools (Beakers, weighing scale, cylinders)
- Sterile containers: (Petri plates, flasks, Sterile tips).

✞ For 10% concentration:

Preparation:

We have used 10 grams of fresh Potato peel paste per 100 ml of distilled water to make 10% concentration.

Procedure:

We boiled the above the mixture for 10 to 15 minutes Then cool down the mixture and add 2.5 gm Agar-Agar powder in it. Then we mixed well using glass rod and then autoclave it. Then sterilize media by autoclaving at 121 degree C for 15-20 minutes at 15 psi pressure.

After sterilization we prepared the plates and allowed them solidified the media. Took the 100 uL of soil diluted suspension of different concentration (10^{-2} to 10^{-6}) and spreader on different plates respectively (labelled). Then incubates the plates upside down at 37 degree C for 24 to 48 hours.

✞ For 20% concentration:

Preparation:

Used 20 grams of fresh Potato peel paste per 100 ml of distilled water to make 20% concentration.

Observation:

After incubation well isolated colonies are observed and take one of the colonies

✞ POTATO PEEL POWDER MEDIA (PPP)

○ . Preparation of Potato peel powder media:

✞ For 1% Potato peel powder media

Preparation:

We have used 1 gram of fresh Potato peel powder per 100 ml of distilled water to make 1% concentration.

Procedure:

We take 1 gram potato peel powder and add 2.5 gm Agar-Agar powder in 100ml dist water. Then we mixed well using glass rod and then autoclave it. Then sterilize media by autoclaving at 121 degree C for 15-20 minutes at 15 psi pressure.

After sterilization we prepared the plates and allowed them solidified the media. Took the 100 uL of soil diluted suspension and spreader on different plates respectively (labelled). Then incubates the plates upside down at 37 degree C for 24 to 48 hours.

✞ For 2% potato peel powder media:

Preparation:

Used 2 grams of fresh Potato peel powder per 100 ml of distilled water to make 2% concentration.

Observation:

After incubation well isolated colonies are observed and take one of the colonies.

✞ For 5% Potato peel powder media:

Preparation:

Used 5 grams of fresh Potato peel powder per 100 ml of distilled water to make 5% concentration.

Staining:

After incubation well isolated colonies are observed and take one of the colonies.

Potato peel powder typically has a fine to medium texture, often slightly gritty or earthy due to the natural fiber content. The texture can vary depending on the grinding process and the potato variety used. Generally, the powder is smooth enough to be used in food, cosmetics, or animal feed applications, but it may retain some slight texture from the potato peels.

RESULT

✞ RESULTS:

• **Collection of Soil:**

Collected small samples from various points within the contaminated are and mixed them to get a sample. Soil is collected from the industrial sites and waste areas. Kept that soil samples in cool, dark place during the project.

✞ MAKING OF BANANA PEEL POWDER:

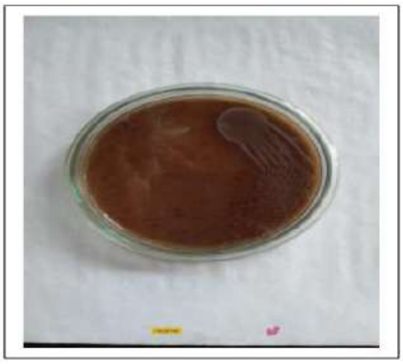
Collected Banana peels are dried and grind using grinder to convert into powder form.

Fig no 1: (Collected banana peels) (Banana peel drying) (Banana peel powder)

Fig no 2: (Peel powder media plates)

For 1% concentration:

After incubation we got the well isolated colonies.

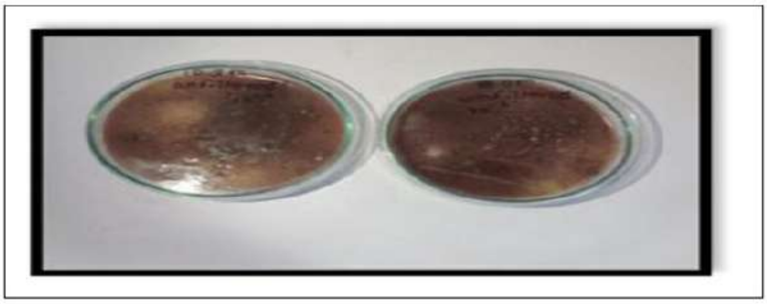


For 2% concentration:

After incubation we got the well isolated colonies.

For 5% concentration:

After incubation we got the well isolated colonies.



✞ MAKING OF POTATO PEEL POWDER:

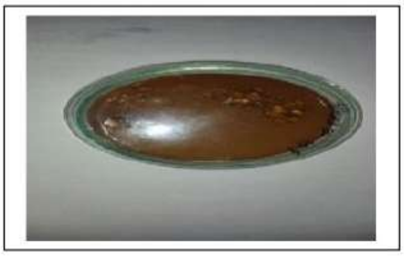
Collected Potato peels are dried and grind using grinder to convert into powder form.

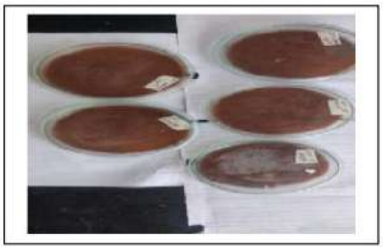
Fig no3:	**(Collected potato peels)**	**(Potato peel drying)**	**(Potato peel powder)**

For 1% concentration

For 2% concentration:

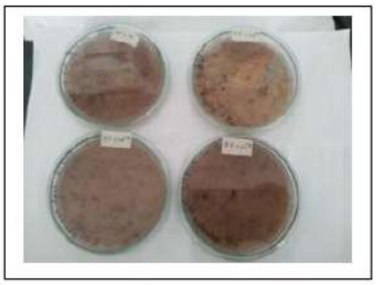
After incubation we got the well isolated colonies.





For 5% concentration:

After incubation we got the well isolated colonies.



♰ COMPARISON OF MICROBIAL GROWTH BETWEEN BANANA PEEL POWDER, POTATO PEEL POWDER AND NUTRIENT AGAR PLATES BY USING MOTHER CULTURE OF DIFFERENT ORGANISMS:

Fig no 4: Potato peel powder showing the microbial growth of diff organism.

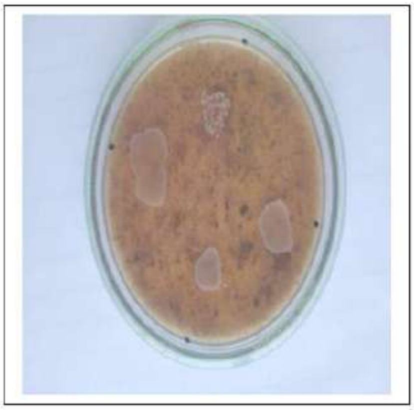
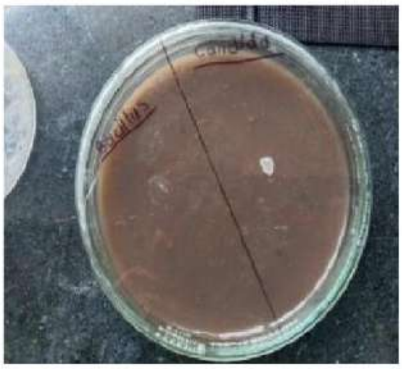


Fig no 5: Nutrient agar plates showing the microbial growth of diff organism.

Fig no 5: Banana and Potato agar growth of diff organism.



Comparison of Microbial growth between Banana peel agar (BPA), Potato peel (PPA) and Nutrient agar (NA) plates by using Mother culture of different organisms:

We take one plates of each agar media (Banana peel powder, Potato peel powder and Nutrient agar) and strike suspension of different organisms like ***E. coli, Candida spp. Bacillus spp. Staph. aureus*** on each media by using wire loop. Incubate plates at 37 degree C for 24-48 hrs. After incubation we compare the growth of Microorganisms.

Table 1: Comparison between the BPA and PPA

Microorganism	Type	Growth on BPA	Growth on PPA
E.coli	Gram-negative rod bacterium	Moderate, smaller colonies, ferment sugars	Moderate; utilize starch with lower efficiency
Bacillus spp.	Gram-positive rod, spore-forming	Moderate; often produces flat, rough colonies; possible pigment	Variable; some spp. Grow better due to starch metabolism
S. aureus	Gram-positive cocci	Moderate; goldenyellow colonies if pigment is expressed	Moderate; colonies may less pigmented
Candida spp.	Yeast (fungus)	Grows well; creamy colonies;	Good growth; colonies appear creamy to pasty.

Table 2: Morphological comparison between NA, BPA, PPA using E.coli, candida spp., Bacillus spp. And S. aureus organisms.

organism	Medium	Colony size	Shape	Color	Texture	Elevation
E.coli	NA	Large	Circular	Offwhite/gray	Smooth, moist	Raised
	BPA	Medium	Circular	Pale yellow	Slightly mucoid	Sightly raised
	PPA	Small	Irregular	Dull white	Dry, rough	Flat
Candida spp.	NA	Medium	Circular	Creamy white	Smooth, soft	Convex
	BPA	Large	Circular	Cream to pale pink	Mucoid, shiny	Raised
	PPA	Medium	Irregular	Dull white	Dry, wrinkled	Convex
Bacillus spp.	NA	Large	Irregular	White/off white	Dry, rough edges	Flat
	BPA	Large	Irregular	Creamy	Rough, spread out	Flat
	PPA	Medium	Irregular	Dull white	Matte, dry	Sightly raised
S. aureus	NA	Medium	Circular	Golden yellow	Smooth, shiny	Convex
	BPA	Medium	Circular	Pale yellow	Slightly mucoid	Sightly raised
	PPA	Small	Circular	Whitish	Dry, dull	Flat

DISCUSSION

✞ Discussion:

The present study focused on the preparation and characterization of potato peel powder (PPP) as a value-added product derived from agro-industrial waste. The results obtained suggest that potato peels, often discarded as waste, possess significant nutritional and functional properties that can be harnessed for various applications.

Proximate analysis of the potato peel powder revealed a substantial amount of dietary fiber, carbohydrates, and trace proteins, indicating its potential as a nutritional enhancer in food formulations. The fiber content, in particular, supports its use in the development of high-fiber bakery and snack products.

The functional properties, including water absorption capacity, oil absorption, and bulk density, were found to be suitable for use in food processing. These properties enable PPP to improve texture, moisture retention, and shelf life when incorporated into food systems.

Additionally, the presence of bioactive compounds such as polyphenols and flavonoids suggests antioxidant potential, which could contribute to health benefits and product preservation. In some studies, PPP has also demonstrated mild antimicrobial activity, particularly against common foodborne pathogens, further supporting its role as a functional ingredient.

In terms of sustainability, the use of potato peel aligns with waste valorization practices, helping reduce environmental pollution and promoting circular economy principles. By converting waste into a valuable resource, the project also demonstrates an eco-friendly approach to food innovation.

However, the study also faced limitations such as variation in peel composition depending on potato variety, and the need for pretreatment to ensure safety and quality. Further research could explore PPP's performance in real food systems, its sensory impact, and consumer acceptance.

Overall, the results highlight the potential of potato peel powder as a low-cost, sustainable ingredient with diverse applications in food, packaging, and possibly even water purificationThis study aimed to evaluate and compare the effectiveness of banana peel powder (BPP), potato peel powder (PPP), and standard nutrient agar as growth media for different microorganisms—Escherichia coli, Bacillus spp., Candida spp., and Staphylococcus aureus. The objective was to determine whether agro-waste-derived powders could serve as alternative, low-cost media for microbial culture, particularly in resource-limited settings.

Growth patterns observed on BPP and PPP media varied significantly across the organisms tested. As expected, nutrient agar showed the highest and most consistent growth for all four microorganisms, given its optimized composition tailored for microbial proliferation.

However, both BPP and PPP supported noticeable growth, though to a lesser extent and with differences depending on the microorganism:

E. coli exhibited moderate growth on both BPP and PPP. BPP supported slightly better growth, possibly due to the presence of fermentable sugars and readily available carbohydrates in banana peels.

Bacillus spp., being a hardy, spore-forming bacterium, grew relatively well on all three media. Growth on PPP was slightly better than on BPP, likely due to the starch and protein content in potato peels, which may serve as better substrates for Bacillus metabolism.

Candida spp. showed minimal growth on both peel-based media. This may be due to the lack of specific nutrients (e.g., nitrogen or vitamins) essential for fungal growth that are abundant in nutrient agar but scarce in BPP and PPP.

Staphylococcus aureus demonstrated moderate growth on BPP and low to moderate on PPP. Again, BPP's sugar and moisture retention properties might have supported better growth for this facultative anaerobe.

Overall, BPP performed slightly better than PPP in terms of supporting microbial growth, particularly for E. coli and S. aureus. This can be attributed to its richer content in simple sugars, potassium, and moisture-retaining fibers. However, both peel powders showed potential as alternative media, especially for preliminary microbial studies or in situations where conventional media are unavailable or expensive.

The variation in microbial growth highlights the influence of nutrient availability, moisture content, and natural antimicrobial compounds (like phenolics in banana or potato peels). It's also possible that residual antimicrobial phytochemicals in the peels could have partially inhibited the growth of some organisms, particularly Candida.

In conclusion, while neither BPP nor PPP can fully replace nutrient agar for clinical or high-precision microbiology work, they offer a cost-effective, sustainable alternative for basic cultivation, educational purposes, and low-resource environments. Further enhancement of these media through nutrient fortification or pH adjustments could improve their performance.

CONCLUSION

✞ CONCLUSION:

The study demonstrated that both banana peel powder (BPP) and potato peel powder (PPP) can serve as viable, low-cost alternatives to commercial nutrient agar for microbial growth. The standard nutrient agar, BPP and PPP supported the growth of organisms such as *E. coli, Bacillus spp., Candida spp., and Staphylococcus aureus* to varying degrees. BPP generally showed better support for microbial proliferation, likely due to its higher sugar and nutrient content. These findings highlight the potential of agro-waste-based media in resource-limited settings, promoting sustainability and reducing laboratory costs. Further optimization and nutrient supplementation could enhance their effectiveness for broader microbiological applications. we can also use this media as a source of substrate for production of amylase enzyme.

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