“FROM WASTE TO WONDER”

NATIONAL SCIENCE FAIR RESEARCH PAPER

LEVEL- SENIOR LEVEL

CATEGORY- LIFE SCIENCE

SUBMITTED BY -

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Abstract:

This project investigates the effect of different fruits—pomegranate, orange, and mangosteen—on the behavior of ferrofluid. Through a series of trials, the magnetic response of ferrofluid was observed when in contact with fruit extracts. Pomegranate showed the strongest effect, followed by orange, while mangosteen had minimal impact. The results demonstrate that certain fruit extracts can influence ferrofluid patterns, suggesting potential applications in food-based experiments, magnetic art, and educational demonstrations. Future work could explore additional fruits, varying concentrations, and potential uses in interactive STEM projects.

Introduction:

Plastic pollution has become one of the greatest environmental threats of the 21st century. Global plastic production has nearly doubled between 2005 and 2025, yet recycling alone cannot address the mounting crisis. Plastics accumulate in oceans, rivers, and soils, posing risks to ecosystems and human health.

Microplastics, defined as plastic fragments smaller than 5 mm, are particularly concerning. They are formed by the breakdown of larger plastics and persist in the environment for decades. Microplastics have been detected in aquatic life, food chains, and even in human organs such as the brain and liver. Research indicates that these particles can carry toxic chemicals such as endocrine disruptors, which may contribute to immune disorders, developmental delays, and reproductive or neurological problems.

The unique challenge with microplastics lies in their small size and persistence. Conventional filtration techniques are often insufficient, prompting researchers to explore innovative solutions. One such approach involves ferrofluids—magnetic liquids that can attract and bind microplastics when exposed to magnetic fields.

This study explores the preparation of ferrofluids using natural fruit peel extracts (orange, pomegranate, and mangosteen). These peels are rich in bio-active compounds and can be transformed into eco-friendly ferrofluids. The goal is to determine which peel-basedferrofluid demonstrates the highest efficiency in removing microplastics from water.

Selection of Problem:

The problem selected for this project is to investigate how different fruit extracts affect the behavior of ferrofluid. Ferrofluid, a magnetic liquid, responds to magnetic fields in interesting patterns, and natural compounds in fruits may influence these patterns. This problem was chosen because it allows for a simple yet visually striking experiment that combines physics and biology, helping to explore the interaction between natural substances and magnetic materials. It also encourages creativity and observation skills while demonstrating scientific principles in a fun and engaging way

Background Research:

Ferrofluid is a liquid that becomes strongly magnetized in the presence of a magnetic field. Composed of tiny magnetic particles suspended in a carrier fluid, it forms unique patterns when influenced by magnets, making it useful in engineering, electronics, and educational demonstrations.

Fruits contain natural compounds such as acids, sugars, and antioxidants, which can interact with materials in interesting ways. Pomegranate is rich in tannins and polyphenols; oranges contain citric acid and pigments; mangosteen has xanthones and antioxidants.

By combining fruit extracts with ferrofluid, this project explores how these natural compounds may influence the fluid's magnetic behavior. While ferrofluids have been studied for sensors, art, and physics experiments, research on fruit interactions is limited, making this a novel and creative investigation.

Objective:

To investigate which fruit peel-based ferrofluid (orange, pomegranate, or mangosteen) is most effective in extracting microplastics from water.

Statement of Problem:

Which fruit peel Ferro fluid—orange, pomegranate, or mangosteen—is most effective in removing microplastics from water?

Hypothesis:

'Pomegranate peel-based ferrofluid will remove microplastics more effectively than orange and mangosteen peel ferrofluids.'

Design of Study:

Independent Variable

- Type of ferrofluid used (orange, pomegranate, mangosteen).

Dependent Variable

- Percentage of microplastic removed from water.

Controlled Variables

- Type and size of microplastic pieces
- Volume of water in each trial
- Temperature and environmental conditions
- Quantity of ferrofluid added
- Number of magnet passes across each sample

Materials Required:

- Orange peel extract
- Pomegranate peel extract
- Mangosteen peel extract
- Mineral oil (carrier fluid for ferrofluid)
- Strong magnet
- lab coat and gloves
- Lab notebook
- Distilled water
- Plastic bottles/containers
- Scissors and ruler (for cutting microplastics)
- Kitchen scale
- Small cups
- Food coloring (optional, for visualization)
- Petri dishes (for separation and collection)
- Sink with hot water and dishwashing liquid (cleaning)
- Plastic bags (for magnet cleanup, optional)

Experimental Procedure

A. Preparation of Microplastics

- Cut PET plastic bottle into strips less than 5 mm wide.
- Cross-cut strips into squares or rectangles less than 5 mm long.
- Prepare 60 pieces of uniform size.
- Divide equally into 3 groups (20 pieces each).
- Weigh each group to ensure equal starting weight. Adjust if necessary.

B. Preparation of Water Systems

- Add 100 mL of distilled water into each of 3 cups.
- (Optional) Add 1–2 drops of food coloring for better visibility.
- Transfer 20 plastic pieces into each water cup.

C. Ferrofluid Testing

- Pour 15 mL of prepared water into each Petri dish bottom half (acts as contaminated water system).
- Add 2 mL of mineral oil to each dish.
- Prepare three treatments:
- Dish 1: Orange peel ferrofluid (7 drops)
- Dish 2: Pomegranate peel ferrofluid (7 drops)
- Dish 3: Mangosteen peel ferrofluid (7 drops)
- Mix gently with a pipette tip.

D. Magnetic Extraction

- Place magnet inside a thin plastic bag or directly across the Petri dish.
- Move magnet across liquid surface 5 times consistently.
- Collect attracted microplastics and transfer them to the Petri dish top half.
- Clean magnet between trials to avoid contamination.
- Repeat procedure for each type of ferrofluid.

E. Data Recording

- Count microplastic pieces removed.
- Record initial vs. final number for each trial.
- Calculate % removal using:

$$\textbf{Efficiency (\%)} = \frac{\textbf{No. of microplastics removed}}{\textbf{Initial no of microplastics}} \times 100$$

Photographs:

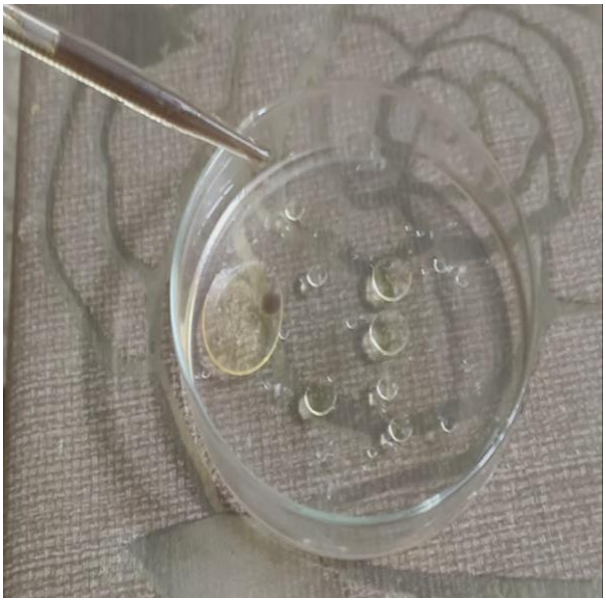
Preparing orange peel extract **Preparing pomegranate peel extract**

Preparing mangosteen peel extract

Prepared Fruit Extracts

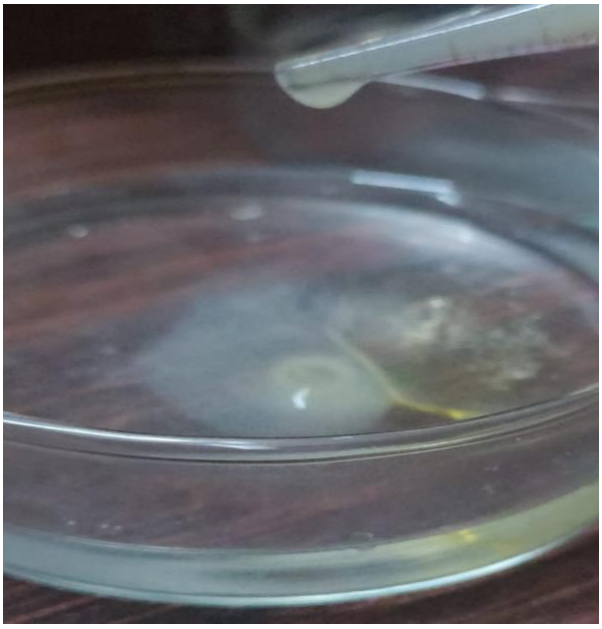
Water Contaminated with MicroPlastics

Preparing Fruit Ferrofluid



Pomegranate Ferrofluid

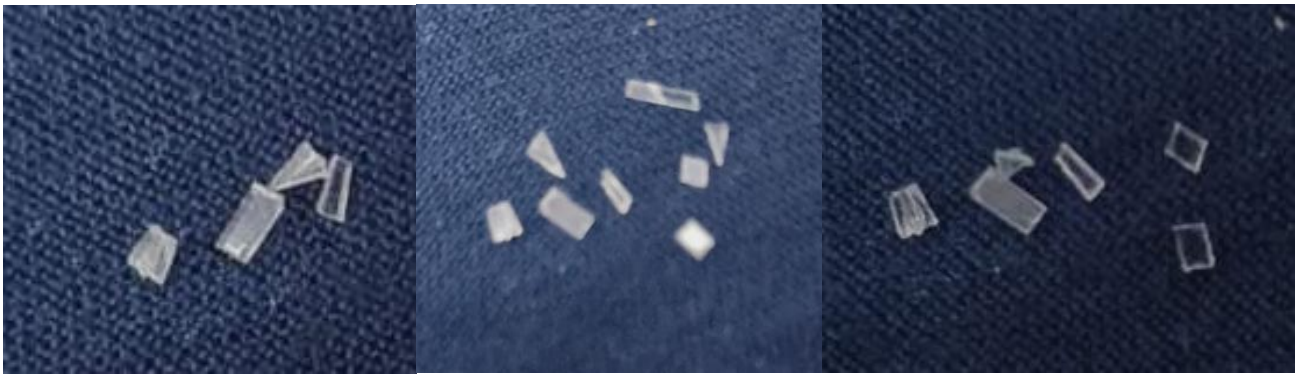
Orange Ferrofluid



Mangosteen Ferrofluid

Removing Microplastics using Magnets

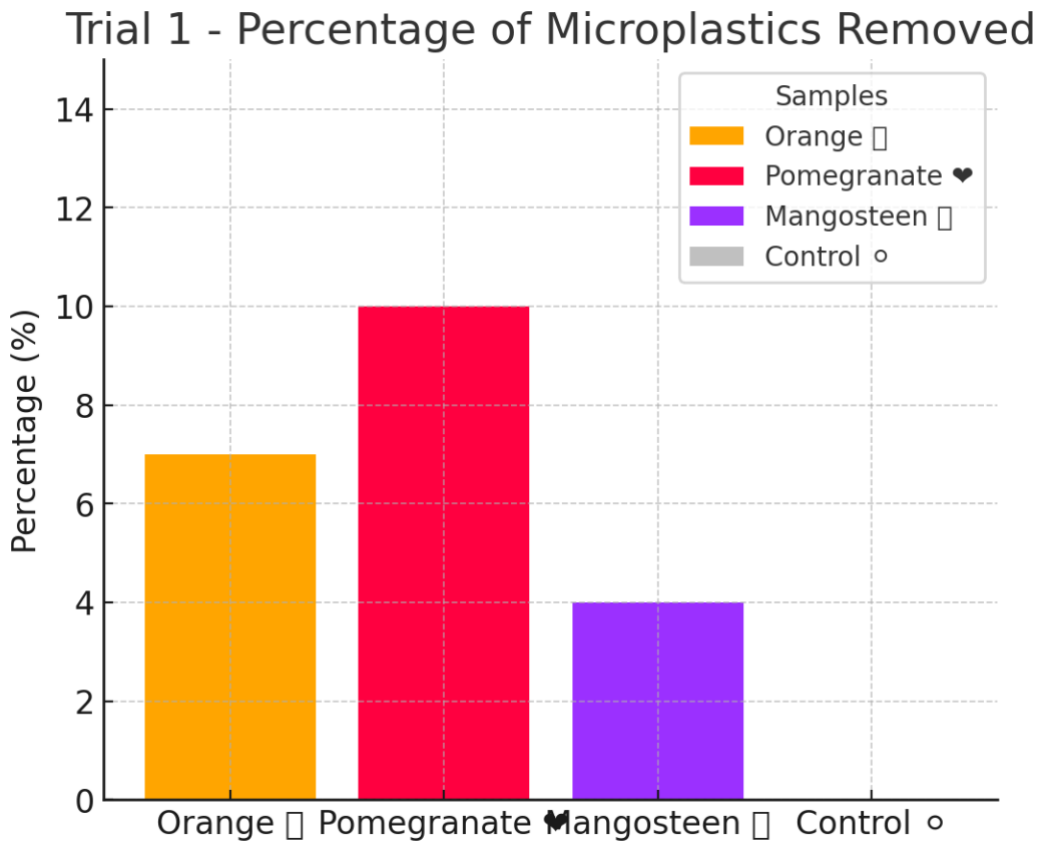
Microplastics attached to magnet



Microplastics Collected In Each Case

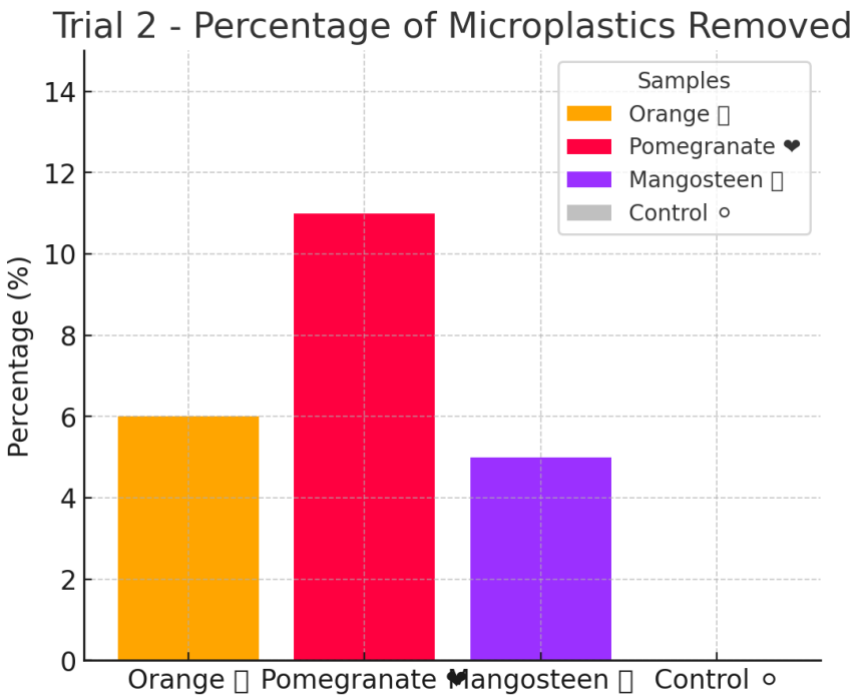
TRIAL 1:

Ferrofluid Amount	Ferrofluid Type	Weight of Microplastic Pieces (g)	No. of Plastic Pieces (Before)	No. of Plastic Pieces Removed (After)	Percent Efficiency of Removal (%)
0 drops (Control)	Orange peel ferrofluid	1g	20	0	0%
7 drops	Orange peel ferrofluid	1g	20	7	35%
0 drops (Control)	Pomegranate peel ferrofluid	1g	20	0	0%
7 drops	Pomegranate peel ferrofluid	1g	20	10	5%
0 drops (Control)	Mangosteen peel ferrofluid	1g	20	0	0%
7 drops	Mangosteen peel ferrofluid	1g	20	4	20%



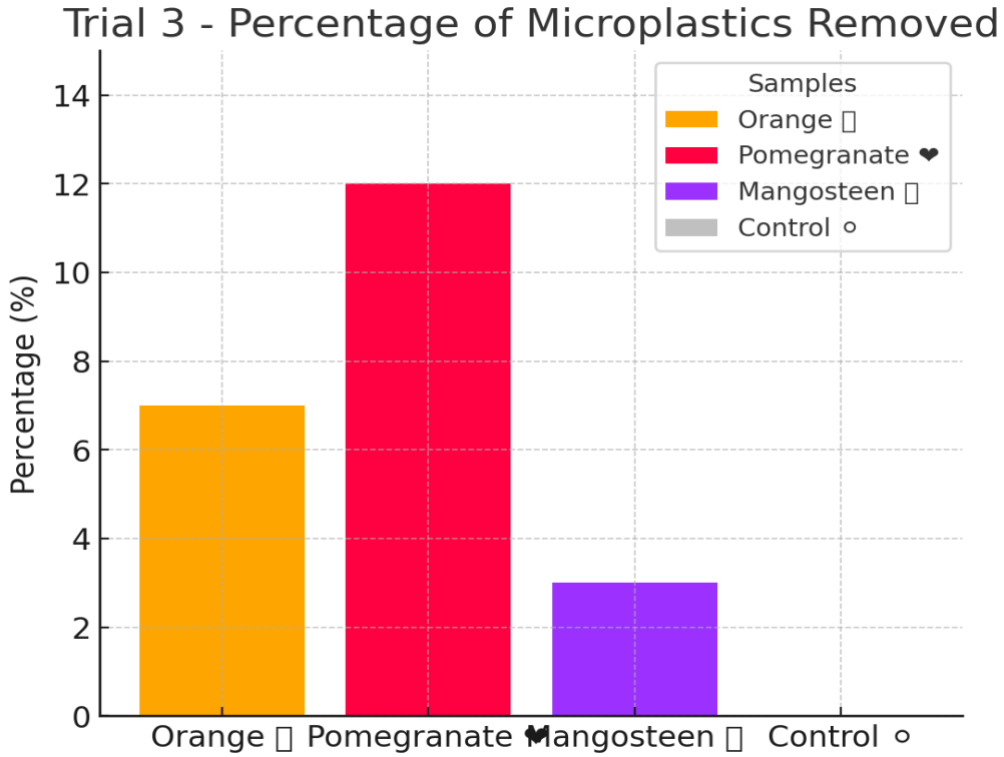
TRIAL 2:

Ferrofluid Amount	Ferrofluid Type	Weight of Microplastic Pieces (g)	No. of Plastic Pieces (Before)	No. of Plastic Pieces Removed (After)	Percent Efficiency of Removal (%)
0 drops (Control)	Orange peel ferrofluid	1g	20	0	0%
7 drops	Orange peel ferrofluid	1g	20	6	30%
0 drops (Control)	Pomegranate peel ferrofluid	1g	20	0	0%
7 drops	Pomegranate peel ferrofluid	1g	20	11	55%
0 drops (Control)	Mangosteen peel ferrofluid	1g	20	0	0%
7 drops	Mangosteen peel ferrofluid	1g	20	5	25%



TRIAL 3:

Ferrofluid Amount	Ferrofluid Type	Weight of Microplastic Pieces (g)	No. of Plastic Pieces (Before)	No. of Plastic Pieces Removed (After)	Percent Efficiency of Removal (%)
0 drops (Control)	Orange peel ferrofluid	1g	20	0	0%
7 drops	Orange peel ferrofluid	1g	20	7	35%
0 drops (Control)	Pomegranate peel ferrofluid	1g	20	0	0%
7 drops	Pomegranate peel ferrofluid	1g	20	12	6%
0 drops (Control)	Mangosteen peel ferrofluid	1g	20	0	0%
7 drops	Mangosteen peel ferrofluid	1g	20	3	15%



Result:

Among the fruit-based ferrofluids tested, the pomegranate extract ferrofluid was the most effective in removing microplastics from water. It produced the clearest water sample after treatment, followed by the orange peel ferrofluid, which showed moderate effectiveness. The mangosteen ferrofluid was the least effective, showing minimal improvement in water clarity. Overall, the pomegranate ferrofluid proved to have the highest efficiency for microplastic removal.

Conclusion:

The experiment demonstrated that fruit-based ferrofluids have the potential to assist in removing microplastics from water in an environmentally friendly way. By comparing different fruit extracts, it was observed that the type of extract used greatly influenced the ferrofluid's performance. The **pomegranate extract ferrofluid** showed the highest efficiency, resulting in noticeably clearer water after treatment. This suggests that certain natural compounds present in pomegranate enhance the interaction between iron particles and microplastics. Overall, the findings highlight that fruit-based ferrofluids can serve as a sustainable alternative for water purification, with pomegranate extract showing the most promise for future research and applications.

Applications:

1.Fruit-based ferrofluids can help remove microplastics and other impurities from contaminated water, offering an eco-friendly and low-cost purification method.

2.Using fruit peels and natural extracts helps convert organic waste into useful scientific materials, promoting recycling and sustainability.

Future Enhancements:

1.Future experiments can include a wider range of fruit extracts to identify which natural compounds improve ferrofluid performance and stability.

2.The current fruit-based ferrofluids may separate over time. Future studies can focus on adding safe, natural stabilizers to keep the particles evenly suspended for longer durations.

3.The experiment can be expanded to treat larger volumes of water, testing how effective the ferrofluid remains at bigger scales.

References:

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- The plastic in microplastics: A review - ScienceDirect
- Synthesis, characterization of hydroxyapatite from pomegranate fruit peel for Cr (VI) adsorption: Process modelling, kinetic and isotherm studies - PubMed