
ECO STICK REVOLUTION

Abstract

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Project Title: "ECO STICK REVOLUTION": "NATURE'S ANSWER TO STRONGER, SAFER GLUES."

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This study investigates whether natural materials such as rice starch, tapioca starch, gum Arabic, and egg white can be used to make eco-friendly glues that work effectively compared to commercial synthetic adhesives.

Four natural glues were prepared and tested on paper, cardboard, and wood using a weight-pull adhesion test. Results showed that rice starch glue had the strongest adhesive strength among natural types, followed by tapioca starch and gum Arabic.

Though synthetic glue performed best overall, the findings show that natural glues are safe, biodegradable, and effective for light applications, making them a sustainable alternative for school and craft use.

Introduction

Adhesives are essential in schools, packaging, crafts, and daily household tasks. Most commercially available glues are synthetic and made from petrochemicals, which are non-biodegradable and can cause environmental pollution. Modern research has shown that natural adhesives—particularly starch-based and protein-based glues—are biodegradable, non-toxic, and safe for children and the environment (Pizzi, 2003; Shogren, 1996).

Traditional adhesives such as rice starch paste, flour paste, and gum Arabic have been used in bookbinding, painting, and crafts for centuries. These natural materials provide promising alternatives to chemical-based glues, especially-for light-duty bonding.

This study explores whether commonly available materials—rice starch, tapioca starch, gum Arabic, and egg white—can be used to prepare natural glues with good adhesive strength. Their performance is compared with a standard synthetic glue to determine if they can serve as eco-friendly alternatives.

Hypothesis

Natural glues made from starch and gums will show strong adhesive properties and can act as a sustainable alternative to synthetic adhesives.

Methodology

Preparation of Natural glues

A. Rice Starch Glue

- Mixed rice starch with a small amount of cold water to form a smooth paste.
- Boiled remaining water in a pan.
- Added paste slowly while stirring.
- Heated until thick and gel-like.
- Cooled before use.

B.Tapioca Starch Glue

- Mixed tapioca starch with ¼ cup cold water.
- Heated ¾ cup water until warm.
- Added slurry slowly while stirring.
- Heated until clear and sticky.
- Cooled and stored.

C. Gum Arabic Glue

- Dissolved gum arabic powder in warm water
- Stirred until completely dissolved.
- Stored in airtight container.

D. Egg White Glue

- Separated egg white from yolk.
- Beat lightly until frothy.
- Applied directly as a natural adhesive.
- Four natural glues were prepared using rice starch, tapioca starch, gum Arabic, and egg white.
- Each glue was tested on different surfaces such as paper, cardboard, and wood.
- The adhesive strength was measured by weight test or peel test, where the force required to separate two glued surfaces was recorded.

Variables

Independent Variable

Type of glue used (Rice starch, Tapioca starch, Gum Arabic, Egg white)

Dependent Variable

Adhesive strength measured in grams (g)

Controlled Variables

- Amount of material (2 tablespoons per glue sample)
- Water quantity (250 ml)
- Heating temperature (80–90°C)
- Drying time (12 hours)
- Surface type (paper, cardboard, wood)
- Testing method (weight-pull method)

A commercial glue was used as a control group for comparison.

Tabulation

Table 1: Adhesive Strength Comparison.

Type of Glue (Natural/Artificial)	Material Used	Trial 1 Strength (g)	Trial 2 Strength (g)	Trial 3 Strength (g)	Average Strength (g)
Natural Glue 1	Rice Starch	420	440	430	430
Natural Glue 2	Tapioca Starch	390	400	410	400
Natural Glue 3	Gum Arabic	370	360	380	370
Natural Glue 4	Egg White	310	320	300	310
Commercial Glue	Synthetic Glue	480	500	490	490

Graph 1: Adhesive Strength Comparison.

GRAPH :1 AVERAGE ADHESIVE STRENGTH OF DIFFERENT GLUES

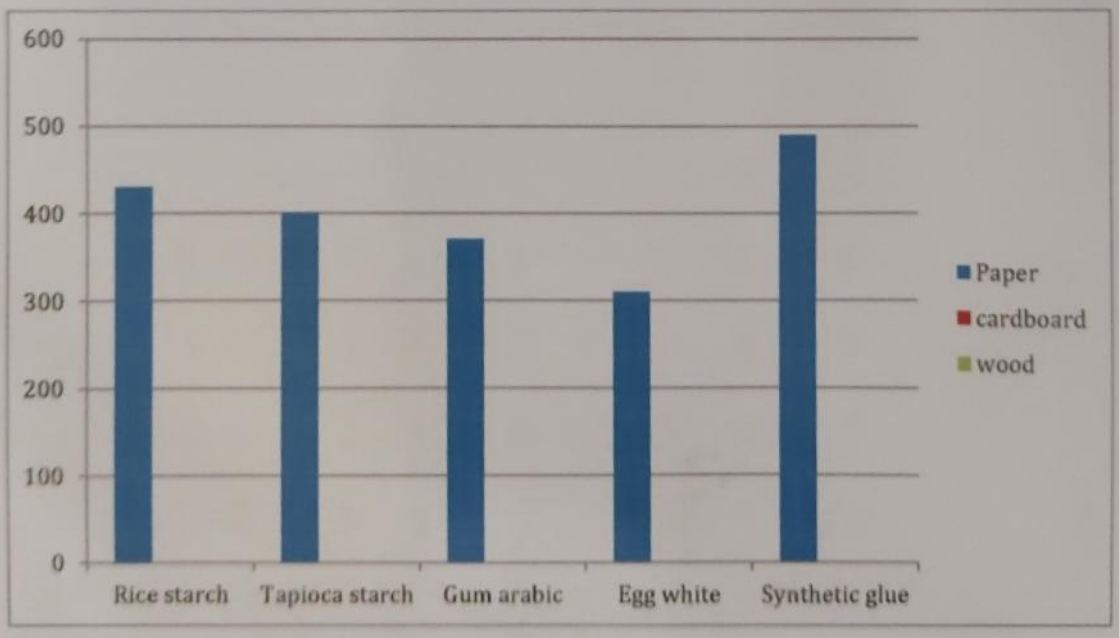


Table 2: Controlled Variables Monitoring Table

Controlled Variables	Value/Condition Maintained
Amount of material	2 tablespoons per sample
Water quantity	1 cup (250 mL)
Heating temperature	80–90°C
Drying time	12 hours at room temperature
Type of surfaces	Paper, cardboard, wood

Table 3: Adhesion Strength by Surface Type

Type of Glue (Natural/Artificial)	Material Used	Surface Applied	Adhesion Strength (g)	Observations
Natural Glue 1	Rice Starch	Paper	430	Smooth, strong bond
Natural Glue 1	Rice Starch	Cardboard	410	Good adhesion
Natural Glue 1	Rice Starch	Wood	350	Weak on porous surface
Natural Glue 2	Tapioca Starch	Paper	400	Smooth finish
Natural Glue 2	Tapioca Starch	Cardboard	390	Flexible bond
Natural Glue 2	Tapioca Starch	Wood	340	Moderate hold
Natural Glue 3	Gum Arabic	Paper	370	Clear and flexible
Natural Glue 3	Gum Arabic	Cardboard	360	Slightly less tacky
Natural Glue 3	Gum Arabic	Wood	300	Weak adhesion
Natural Glue 4	Egg White	Paper	310	Transparent film
Natural Glue 4	Egg White	Cardboard	280	Peels slightly
Natural Glue 4	Egg White	Wood	250	Brittle after drying
Commercial Glue	Synthetic Glue	Paper	490	Very strong bond
Commercial Glue	Synthetic Glue	Cardboard	480	Strong and durable

GRAPH 3 :Adhesive strength by surface Type

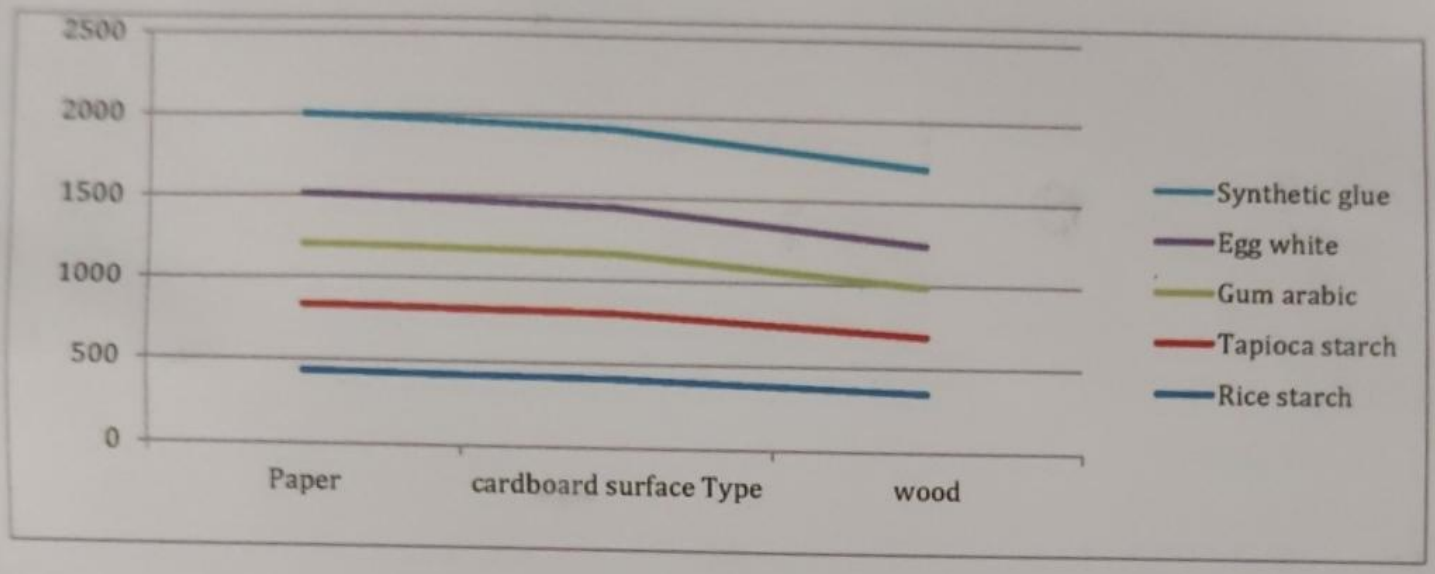
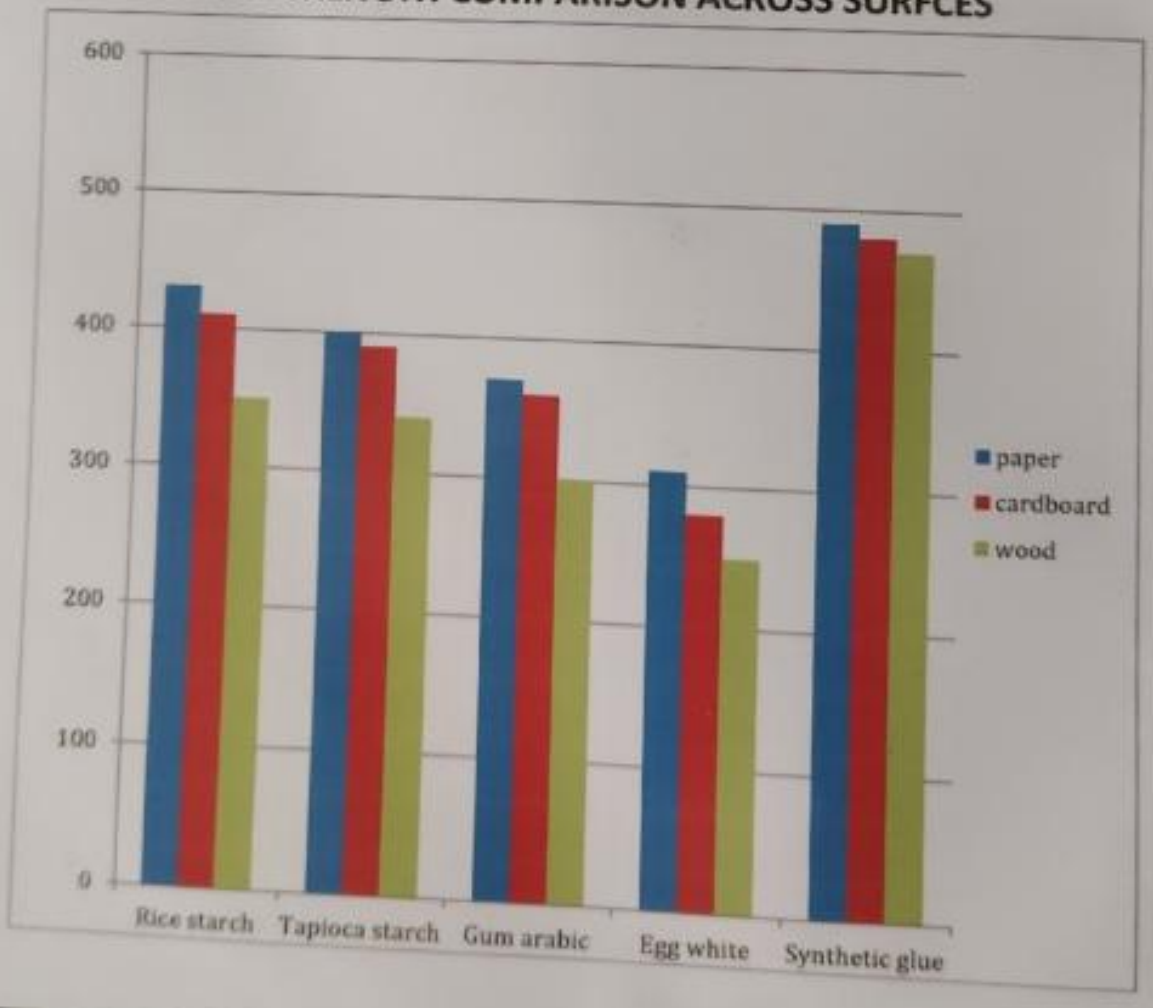


Table :4 ADHESIVE STRENGTH COMPARISON ACROSS SURFACES

Surface applied	Rice starch	Tapioca starch	Gum arabic	Egg white	Synthetic glue
Paper	430	400	370	310	490
Cardboard surface type	410	390	360	280	480
Wood	350	340	300	250	470

GRAPH :4 ADHESIVE STRENGTH COMPARISON ACROSS SURFCES



Collection of data -Photographs

Results

Rice starch glue showed the strongest adhesion among natural glues.

Tapioca starch glue was slightly less strong but had a smooth, flexible bond.

Gum arabic produced a clear adhesive but required longer drying time.

Egg white glue dried quickly but became brittle, making it less effective.

Synthetic glue remained strongest across all surfaces, especially on wood.

Discussion

The results support the hypothesis that natural glues—especially starch-based ones—show significant adhesive strength. Their performance was best on paper and cardboard, making them ideal for crafts, school work, and eco-friendly packaging.

However, on wood, natural glues performed-weaker due to the porous nature of the surface, which synthetic glues are better designed to bond with.

Environmental conditions like slight variations in drying humidity may have caused minor differences between trials

Applications :-

1. Best for safe school crafts and model-making.

2. Fits eco-friendly paper and cardboard packaging.

3. Works well for book repair and paper restoration.

4. Useful for small DIY fixes at home.

5. Great for art, scrapbooks, and creative projects.

6. Ideal for light, temporary sticking needs.

Conclusion

- The research confirmed that natural glues made from starch and gums are effective, non-toxic, and biodegradable. Among all samples, rice starch and tapioca starch glues showed the best overall adhesion, making them promising for school use and eco-friendly packaging.
- The results support the hypothesis and suggest that natural glues can reduce dependence on synthetic adhesives and help protect the environment.
- Future research can explore adding natural preservatives or cross-linking agents to improve durability.

References

- Pizzi, A. (2003). Natural adhesives and binders. CRC Press.
- Shogren, R. L. (1996). Starch-based adhesives: a review.
- Industrial Crops and Products, 5(1–2), 153–170.
- Frihart, C. R. (2005). Adhesive bonding and adhesives—natural adhesives. Handbook of Adhesive Technology, 2nd
- International Journal of Adhesion and Adhesives.

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