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SWEET POTATO (*IPOMOEA BATATAS*) PEELS AS AN ALTERNATIVE NATURAL SOLVENT- BASED ADHESIVE

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A Science Investigatory Project paper
Presented from the Basic Education Department
Of Holy Cross College of Calinan, Inc

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ABSTRACT

Adhesives are used in our everyday life whether in household, school and industry, however, adhesives can also be toxic and addictive to both humans and to the environment. Solvent-based adhesives contains chemicals such as benzene, phthalates and formaldehyde which affects the health of humans. Thus, this study is conducted to test if the mucilage and starch present in sweet potato (*Ipomea batatas*) peels is enough to be a substitute to solvent-based adhesives. The result of this study will be helpful to the community to have a safer substitute to solvent-based adhesives, as this study will help them find a partial solution to the number of addiction cases present in our society. The researchers used an experimental set-up research design to analyze the capability of sweet potato (*Ipomea batatas*) peels to be an adhesive. The independent variable under this experimentation is the mucilage found in sweet potato peels while the binding ability of it is the dependent variable. The study concluded that 2000g Sweet potato (*Ipomea batatas*) peels has enough mucilage and starch to be a substitute adhesive to solvent-based adhesives, though the results are temporary. Therefore, the researchers recommend the future researchers to try using the other parts of the sweet potato *(Ipomea batatas),* try to use other vegetable with similar characteristics to sweet potato *(Ipomea batatas)*, try to use different variants of sweet potato (*Ipomea batatas),* and lengthen the experimentation time. To the government to expand studies in producing organic products such as natural-based adhesives to be used by the government and society to lessen the number of addiction cases as well as to help in the environment.

Keywords: *Solvent based adhesive, Mucilage, Benzene, Phthalates, Formaldehyde*

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INTRODUCTION

Background of the study

Adhesives are used in daily activities of men whether in household, school and industry. But chemicals like benzene, phthalates and formaldehyde are substances that are found to make adhesives making it dangerous to human health especially when inhaled (Cummings & Gushée 2018). Also, adhesives can pollute the air, water, which can also cause the potential loss of wildlife and plant life (Suretacksystem, 2016).

According to UNICEF, there are between 75,000 and 80,000 street children in the Philippines and half of the nation's street kids, aged 8 to 20, have occasionally snorted Rugby and other inhalants (Thern, 2013). Therefore, there is a need to look for an alternative solvent that will not cause addiction and at the same time be environmentally friendly. One of the organic raw materials which has the potential to become adhesive are the sweet potatoes because of its high content mucilage.

Sweet potatoes *(Ipomea batatas)* are a widely used vegetable in the human diet around the world but its processing causes the generation of large amounts of by-products (Martinez, Gullon & Yanez, 2021). Also, sweet potatoes *(Ipomea batatas)* are a starchy tuberous roots (Bjarnadottir,2023). Therefore, the researchers will utilize sweet potatoes peels in ways that are advantageous by making an alternative natural adhesive.

Statement of the Problem:

This study aims to assess the effectiveness of sweet potato *(Ipomea batatas)* peels as a substitute for a solvent-based adhesive. Specifically, it seeks to answer the following questions:

1. Which of the following set ups containing different amount of sweet potato *(Ipomea batatas)* peels is more effective as a substitute adhesive?

   1.1 500g sweet potato peels;

   1.2 1000g sweet potato peels; and

   1.3 2000g sweet potato peels?

2. What is the drying time of the alternative adhesive made of sweet potato *(Ipomea batatas)* peels when applied to the following:

   2.1 Rubber;

   2.2 plastic mineral water caps; and

   2.3 ¼ writing paper

3. What amount of potato peels dry faster when turn into a solvent based adhesive?

   3.1 500g sweet potato peels

   3.2 1000g sweet potato peels

   3.3 2000g sweet potato peels

Hypothesis:

If there is an exact amount of sweet potato *(Ipomea batatas)* peels, then there would be enough mucilage to make a solvent based adhesive.

METHODS AND MATERIALS

The investigation involves 4 phases namely: Phase I –Preparation of materials, Phase II – Extraction of sweet potato peels mucilage powder, Phase III- Making of the adhesive, Phase IV – Data collection and analysis. The experimental procedure is done in the school's laboratory which is in Holy Cross College of Calinan, Davao City.

PHASE I – Preparation of Materials

The sweet potato *(Ipomea batatas)* peels are collected from businesses who sell sweet potato cuisines or delicacies. The researchers will use different materials such as casserole, air fryer, weighing scale, rubber scraper, hanky/clothing, and a stove in making the experiment. The researcher will use water and sweet potato peels as ingredients for the experiment as well as paper, rubber, and plastic for the set ups.

Casserole

Sweet Potato Peels

Weighing scale

Grinder

Stove

Air fryer

Bowl

Container

Cloth

Water

Rubber scraper

Phase II- Extraction of Sweet Potato Peels Mucilage Powder

After collecting the sweet potatoes, the researchers will measure and the measurement differs from set ups, then after the researchers wash the sweet potato peels and prepare for collecting mucilage and starch. The researchers will grind the sweet potato peels adding 300ml water while grinding, pouring another 300 ml water while filtering, and wait for 10 minutes in order for the starch to set. Then the researchers will transfer it into a bowl and drain the water, the starch is then dried under the sun, heating it in the oven or into an air dryer. After this process the researchers will place it in a blender, and it will create a refined powder (Kirby, 2023).

Step 1- Weigh sweet potato peels

Step 2- Wash sweet potato peels

Step 3- Grind

Step 4- Transferring to a cloth

Step 5- Squeeze

Step 6- Rest for 10 min

Step 7- Transferring water to another bowl

Step 8- Air Fry

Powder

PHASE III - Making of the Adhesive and Proper Disposal

The researchers will heat the pan and add the collected mucilage powder and water, the measurement of mucilage powder extracted will differ from 3 set ups, the researchers will stir the mixture until the substance begins to thicken and turns into a paste-like texture and the stirring should be consistent throughout each set ups. Afterwards, the researchers will turn the heat off and let it cool for a minute (Munoz & Michael, 2009). After the experiment the researchers will dispose the used set up materials, put the adhesive in a container storing it carefully for future purposes and the kitchen utensils and pots will be thoroughly washed after the experiment.

Step 1- Measure water

Step 2- Add water and powder

Step 3- Dissolve

Step 4- Turn on heat Step 5- Mix Adhesive



PHASE IV – Data Collection and Analysis

The adhesives will be evaluated using a table based on its drying time and binding abilities. The adhesiveness of the compound substance will be tested through adhesion and the drying time. The results will be shown in a table chart. The researchers first prepared the materials for the experimentation, then apply a table spoon of sweet potato peels adhesive and then observe.

Step 1- Prepare the materials (cutting)



Step2- Applying adhesive to materials Step 3- Observe



RESULTS

This study determined the results of the sweet potato (*Ipomoea batatas*) peels adhesive performance when tested on different materials, the researchers will find which set-up has fast drying time and cohesive strength as presented with the following tables.

Table 1. Checking Differences on Cohesive of Different Set ups

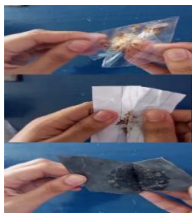
Set-up	Cohesive Strength		
1: 500 grams of Sweet potato pes	Trial 1 	Trial 2 	Trial 3 
2: 1000 grams of Sweet potato peels	Trial 1 	Trial 2 	Trial 3 
3: 2000 grams of Sweet potato peels	Trial 1 	Trial 2 	Trial 3 

Table one show results of the adhesive significant difference observed in the cohesive strength of each set-up. The 3rd set-up proved to have a strong cohesive strength and the weakest is the 1st set-up. The 500g sweet potato peels adhesive trial 1 shows that the adhesive is a bit strong, upon opening the paper ripped but both plastic and rubber is easily split into two that shows the same result as trial 2 and 3. 1000g sweet potato peels trial 1 showed that the adhesive is quite strong the paper tore when opening, while both rubber and plastic was quite strong to be split into two. 2000g of sweet potato peels shows that the adhesive was strong. Upon opening, the paper tore, while the rubber and plastic are moderately hard to open that result shows the same result as trial 2 and 3.

Table 2: Drying of the product

Medium	Time
	**3 hours**
	**3 hours**
	**1 hour**

Table two shows the drying time of each materials, it shows the drying time of each material after the alternative adhesive was added. Trial 1 uses rubber as its material and its drying time is 3 hours. While trial 2 uses plastics as its material and its drying time is also 3 hours. Meanwhile the trial 3 uses paper as its material and the drying time when using the writing paper only takes an hour.

Table 3: Checking Differences on Drying Time

Set-up	Drying time		
1- 500 grams of Sweet potato peels	1 hour 	2 hours 	3 hours 
2: 1000 grams of Sweet potato peels	1 hour 	2 hours 	3 hours 
3: 2000 grams of Sweet potato peels	1 hour 	2 hours 	3 hours 

Table three shows result of the significant difference observed in the drying time of each set-up. The 1st set-up proved to dry the fastest and the 3rd set-up dried lastly. In the first set up the 1st hour of drying time the adhesive in the paper is almost dry, there are parts that are wet while the rubber and plastic is still wet. After 2 hours the materials are almost dry, the paper had already been dried. After 3 hours the paper had already dried while the rubber and plastic still has wet parts found in the center of the material. Set up 2, after an hour of drying the materials are not yet dry. After 2 hours of drying the materials are quite dry. After 3 hours the paper had already dried while the adhesive in the rubber was the same as that in the plastic wherein the adhesive had dried in the sides. Set up 3 an hour of drying the paper is still wet same goes for the rubber and plastic, after 2 hours the results are the same as the 1st hour. In 3 hours, the paper had already dried while the rubber and plastic has the same result wherein the adhesive dried specifically on the sides of the material.

DISCUSSION

The results of the study that is observed was the adhesive's significant difference in the drying time of each set-up wherein the least mucilage and starch has the fastest drying time among the set-ups. This result contradicts to the study of Reotutar, Mamuad and Choi, 2024 which states that on adhesives, the higher the mucilage and starch, the better. When it comes to drying time, the best ratio will be the one that highly obtains the mucilage and starch content value.

Another result shows the difference in the drying time of each set-up made wherein the greater the mucilage and starch the greater it has the ability to have a greater cohesive strength. This result is supported by the study of Mansuri M. Tosif, Agnieszka Najda, Aarti Bains, Ravinder Kaushik, Sanju Bala Dhull, Prince Chawla and Magdanelena Walasek Janusz that the amount of mucilage and starch in adhesives affects how quickly they stick, and how strong the bond is. When there is more the mucilage and starch, there is less water in the adhesive making the adhesive work better. Additionally, a study conducted by Junjun Liu, Lanzhong Guo, Li Yang, Zhong Liu and Chunxia, 2014 stated that the adhesive's thickness is crucial for how strong it holds things together. Starch molecules when spread out well in the adhesive, it becomes thicker thus making the adhesive stick better.

CONCLUSION AND RECOMMENDATIONS

Conclusion

In all of the experimental set-ups, the 2000g sweet potato peels adhesive has shown strong cohesive strength. Therefore, it can be concluded that the greater the amount of the sweet potato peels the mucilage is greater and the cohesive strength is greater and the lesser the amount of sweet potato peels the lesser the mucilage the faster it dries. Based on the results it was able to bind to paper, rubber and plastic. Additionally, 500g dries the fastest from the set ups, based on the result after 3 hours each materials used, simultaneously dries. The adhesive is only for alternative and temporary use since when the adhesive is already too dry the adhesive won't be able to bind anymore. The adhesive works best in paper since until now it still binds.

Recommendations

The researchers recommend to the future researchers to try using the other parts of the sweet potato *(Ipomea batatas),* to use other vegetables with similar characteristics with sweet potato *(Ipomea batatas)*. Different variants of sweet potato (*Ipomea batatas),* and implement the of trials of the experimentation time. To the government to expand studies in producing organic products such as natural-based adhesives to be used by the government and society to lessen the number of addiction cases as well as to help in the environment.

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