



(RESEARCH ARTICLE)



## Utilization of plant-based biodegradable cup as alternative to disposable cup

Jardy Clark Agudo De Guia, Christene Kaye Rico Bancifra, Elijah Laudencia De Leon, Leah Engalla Perez, Frank Moises Datay Reyes and Milbert Jimena Lanuang \*

*College of Education, Laguna University, Santa Cruz, Laguna, Philippines.*

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### Abstract

The study titled "Utilization of Plant-Based Biodegradable Cup as Alternative to Disposable Cup" aims to reduce the production of disposable cups, which cause environmental and health problems. Researchers used wood scobs, bamboo sawdust, coconut husk, agar powder, corn starch, and flour to create plant-based biodegradable cups. Twenty students from Laguna University's Bachelor of Elementary Education and Bachelor of Science in Mechanical Engineering tested the performance of these cups in terms of appearance, aftertaste, and durability compared to commercial disposable paper cups. The results showed a significant difference in appearance, durability, and aftertaste between the two types of cups. The researchers recommend improving the size and shape of the cups, finding an effective substitute for agar, and further studies to prove the safety of the biodegradable cups.

**Keywords:** Acceptability; Aftertaste; Alternative; Appearance; Durability

## 1. Introduction

### 1.1. Nature and Scope of the Problem Investigated.

Different types of disposable cups were commonly used nowadays such as plastic cups, paper cups, and styro cups due to their convenience. However, these said products which are known for being single-use only usually end up as waste and increase the rate of pollution. According to Lebleu (2019), around the world, 500 billion plastic disposable cups are reportedly consumed each year and then almost instantly discarded. It takes approximately 20 years for a paper cup to decompose while a plastic cup takes around 450 years and 500 years for a styro cup. The most effective biodegradable alternative for these disposable cups is polylactic acid also known as corn plastic but this product still has downfall for the most part of the following: The duration of composting for industrial composter is not acquired; The residue is not composted so it doesn't improve the quality of the soil or in short, there is no nutrient added; And lastly, it increases the pH value of the soil resulting in an increase in acidity. By making a plant based biodegradable cup made from different means to trash materials, namely wood scobs, bamboo sawdust, and coconut husk, a potential solution can be created to the increasing amount of non-biodegradable waste mainly in disposable cups. By reducing prospective non-biodegradable waste, there is a possibility of decreasing the level of global warming, climate change, and production of micro plastics. Glass cups, although common in households, are very inconvenient to use compared to other types of cups. Being made out of glass, it is very costly and resource-consuming compared to its counterparts. Creating glass is a highly energy-consuming process due to the high temperatures required for processing the raw materials. Etching of the glass is also an issue in terms of which glass fragments can be consumed while in use, which would eventually lead to complications if a person is long-term exposed to glass intake. Glass is quite fragile in nature and easy to fragment into pieces; glass shards are then hazardous and hard to dispose of. Heat transparency in glass was also an issue; being able to use the cup for hot beverages is possible but impossible to hold the container because it absorbs and retains the heat quite well, or too well to be specific.

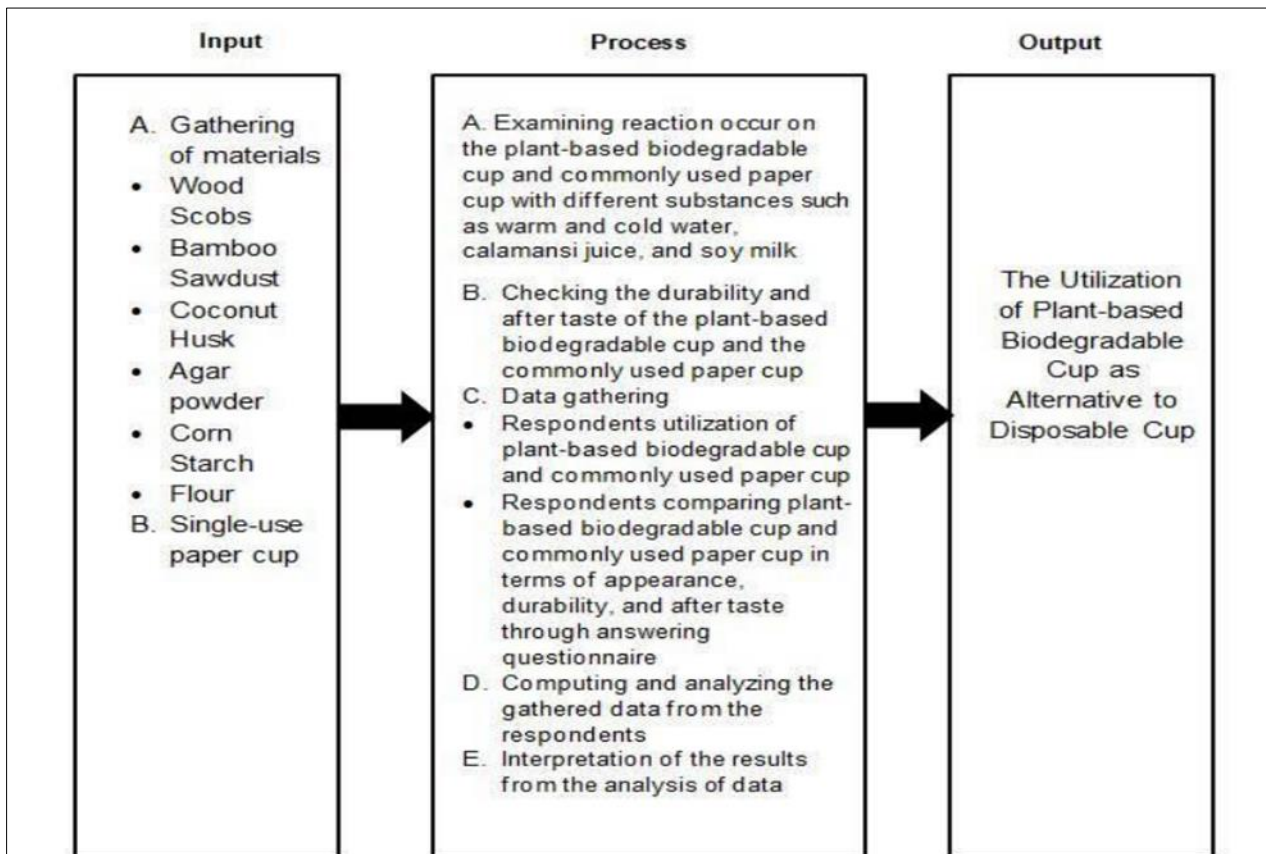
\* Corresponding author: Jardy Clark A. De Guia

### 1.2. Research Problem and Objectives.

The research aimed to utilize plant-based biodegradable cups from powdered wood scobs, coconut husk, bamboo sawdust, agar powder, cornstarch, and flour. Specifically, this sought to answer the following questions in the end of the study:

- What is the level of acceptability of the plant-based biodegradable cups in terms of:
  - Appearance;
  - Durability; and
  - Aftertaste
- What is the level of acceptability among a group of respondents of the commonly used paper cups in terms of:
  - Appearance;
  - Durability; and
  - Aftertaste
- Is there a significant difference between plant-based biodegradable cups and commonly used paper cups in terms of appearance, durability and aftertaste?

### 1.3. Research Framework, as applicable



**Figure 1** Conceptual framework

The study focuses on the use of plant-based biodegradable cups as an alternative to disposable cups. The researchers use an Input-Process-Output Diagram (IPO) to collect materials for the cups, including wood scobs from mahogany trees, bamboo sawdust, coconut husk, agar powder from seaweeds, flour, and corn starch. The process is divided into eight sections, including preparation, trials, evaluation, and testing. The cups are examined for reactions with various substances, including water, calamansi juice, and soy milk, using pH and TDS meters. The cups are also examined for durability and aftertaste, comparing them to paper cups. Data is collected from respondents using plant-based biodegradable cups and paper cups, focusing on appearance, durability, and aftertaste. The study's final conclusion is the success of using plant-based biodegradable cups as an alternative to disposable cups.

#### 1.4. Research Significance

This study aims to determine if plant-based biodegradable cups have potential as alternative to commonly used paper cups. The beneficiaries of the study include the following:

- **Students** - Information from this study will be given to students, particularly those studying science. This will provide them with fresh information and discoveries that will help them advance their studies and become more useful members of society.
- **School** - This research will offer the school knowledge, particularly when it comes to recycling materials like wood scobs, bamboo sawdust, coconut husks, and corn husks. This will assist the school in gathering fresh ideas that can enhance instructions, particularly in trash management. This study's output, a biodegradable cup made of plants, can be utilized for school certification.
- **Entrepreneurs** - This study will give businesses new product ideas, especially those that concentrate on enhancing environmental quality by lowering possible wastes. This study will give entrepreneurs who are concerned with the environment ideas to make new items out of the materials the researchers used.
- **Administration** - This study can provide the administration with ideas on how to reduce the creation of non-biodegradable waste, primarily disposable cups, in order to improve the quality of the environment. The study's product can be utilized as a replacement for the throwaway cups that can be seen in all garbage cans. By implementing an ordinance of using plant-based biodegradable cups, the administration can lessen the production of non-biodegradable waste from disposable cups.
- **Community** - Communities can benefit in this study in terms of livelihood. Local production of cups can boost the economy by a margin from selling it to the market as their locally produced product. It can also reduce the waste produced by the use of the materials that are often thrown out after being used.
- **Future Researchers** - Future researchers, particularly those whose research focuses on creating plant-based biodegradable products as an alternative to non-biodegradable ones, will benefit from the insights provided by this study. The final product of this study can be used as one of their RRS for subsequent research.

#### 1.5. Scope and Limitations

The study's scope is restricted only to the plant-based biodegradable cups and commonly used paper cup's appearance, durability, and aftertaste. The study will focus on the color, shape, texture, and the size of the plant-based biodegradable cups and commonly used paper cups to establish a comparison in terms of appearance. To create a comparison between the plant-based biodegradable cups and commonly used paper cups in terms of durability, it will focus on the ability of the two mentioned cups to hold cold and hot substances and their endurance to physical activities applied by the user such as tapping, squishing, throwing, etc. In terms of aftertaste, to create a comparison between the plant-based biodegradable cups and commonly used paper cups, the study will focus only on the effect of the two mentioned cups on the taste of warm and cold water, calamansi juice, and soy milk. To ensure the safeness of the plant-based biodegradable cups, the researchers will use pH meter and TDS meter to examine the reactions on warm and cold acidic substance (calamansi juice), warm and cold neutral substance (water), and warm and cold alkaline forming substance (soy milk) and compare it to the results of the same examination that will give to the commonly used paper cups; the researchers will also drink the different mentioned substances from the plant-based biodegradable cups and will have self-observation to test the safeness on using the plant-based biodegradable cups for drinking.

##### 1.5.1. Definition of Terms

The following terms were defined according to how they are used in the study:

- **Acceptability** - the qualities of the plant-based biodegradable cups being good enough as a drinking cup.
- **Aftertaste** - the effect of the drinking vessel which is the plantbased biodegradable cups and the commonly used paper cups to the taste of the substance it held.
- **Alternative** – another option or choice that can be used as replacement to disposable cups.
- **Appearance** – the overall look of the plant-based biodegradable cups and the commonly used paper cups concerning color, texture, size, and smell.
- **Durability** – the sturdiness of the plant-based biodegradable cups and the commonly used paper cups and their abilities to withstand different trials such as falling, squishing, and holding warm and cold water.
- **Husk** – is the outer layer that covers a seed or fruit like coconut and mostly has a dry texture.
- **Sawdust** – relatively small and powder like appearance which is the by-product of sawing a bamboo tree.
- **Scobs** – are tiny waste-particles of wood. Plant-based – a product that is made of various plants.

- **Utilization** – to use a sort of materials namely wood scobs, bamboo sawdust, and coconut husk to their max capability in producing the plant-based biodegradable cups.
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## 2. Review of Relevant Literatures

### 2.1. Foreign literature

#### 2.1.1. Paper Cup

Ji Junhui, head of the China National Engineering Research Center for Engineering Plastics, warns against using waxed paper cups for hot beverages due to their risky nature. While polypropylene-coated paper cups are non-toxic and temperature-tolerant, dishonest retailers often use inferior products. He also warns against using waxed paper cups due to the melting paraffin on the inner wall. He recommends using food-grade wax instead.

A study by Professor Tian Junfei at South China University of Technology found that paper cups have a shelf life of one to five years, but they release harmful substances like heavy metal ions. This could be due to poor storage and delivery practices, causing the film covering to deteriorate and overflow with microplastics. The study's generalizability is questionable due to its limited sample size and lack of clarity on expiration dates and safety standards.

### 2.2. Local literature

#### 2.2.1. Paper Cup

Recycling paper has several positive environmental effects. Reusing RCPs helps preserve natural resources by lowering the amount of municipal solid trash produced and dumped in landfills, as well as by reducing the need to cut down as many trees. Additionally, the paper industry's usage of 100 percent recycled products helps to protect forest resources and reduce floods. Standards for recovered paper towards environmental sustainability and paper industry revitalization. (Department of Trade and Industry Philippines. Dti-Ho, P.2022, July 13)

Personalized paper cups are crucial due to their recyclable nature, using cardboard as a material. They are preferred by companies due to their environmental benefits and the security of the interior goods. They are also made with 75% paper and 25% composite material, using a polylactic acid bio covering. (Business Diary PH, 2018)

### 2.3. Foreign literature

#### 2.3.1. Plant-Based Biodegradable Cup

According to Agargel, n.d, agar-agar is insoluble in cold water, but it expands significantly, absorbing up to twenty times its own weight in water. It easily dissolves in boiling water and forms a solid gel at concentrations as low as 0.50%. Also, agar-agar can be used in desserts and other cuisine without altering the taste or fragrance because it has no taste, odor, or color which is specified by Taste.com, n.d.

Compared to paper cups, biodegradable cups are more durable. These cups are less likely to break than paper ones. There are no leaks as well. When they come in contact with hot drinks, no more dangerous substances enter. When compared to plastic cups, they are equally strong. They can even be stronger in some instances. (Clicky E., 2022)

### 2.4. Local literature

#### 2.4.1. Plant-Based Biodegradable Cup

Pinyapel, developed by Filipino material scientists, is a practical substitute for food packaging due to its direct contact with food. It degrades faster than conventional paper, resulting in a 55.32% mass loss in four weeks. Pinyapel can replace takeout containers and improve soil quality, reducing agricultural waste and boosting pineapple producers' livelihoods.

The study tested 40:60 hemp-pineapple peels composite cups for appearance, structure, burst strength, tensile strength, weight load, water leakage, and biodegradability. The cups met visual standards and had similar properties to the control. A 0.70 mm thick beeswax coating prevented leaks and kept cold water in. The cups decomposed in moist sand and active soil environments.

### 3. Methodology

#### 3.1. Research Design

The researchers used experimental research design. Using statistical techniques, experimental design procedures enable the researchers to comprehend and assess the variables that can affect a particular system.

The researchers aimed to create biodegradable cups made from wood scobs, bamboo sawdust, coconut husk, agar powder, cornstarch, and flour. This product was introduced to the selected students of Laguna University determining its effectivity as an alternative to the commercial disposable cup.

#### 3.2. Research Locale

This study was conducted at Laguna Sports Complex, Brgy. Bubukal, Sta.Cruz, Laguna. This place was selected due to its convenience for the study, Utilization of Plant-based Biodegradable Cup as Alternative to Disposable Cups. The study was implemented among the selected 30 students of Laguna University, 15 Mechanical Engineering students were randomly picked same as the 15 Elementary Education students. The study determined if the cups made from wood scobs, bamboo sawdust, coconut husk, flour, cornstarch, and agar powder have the potential as an alternative to commonly used paper cup.

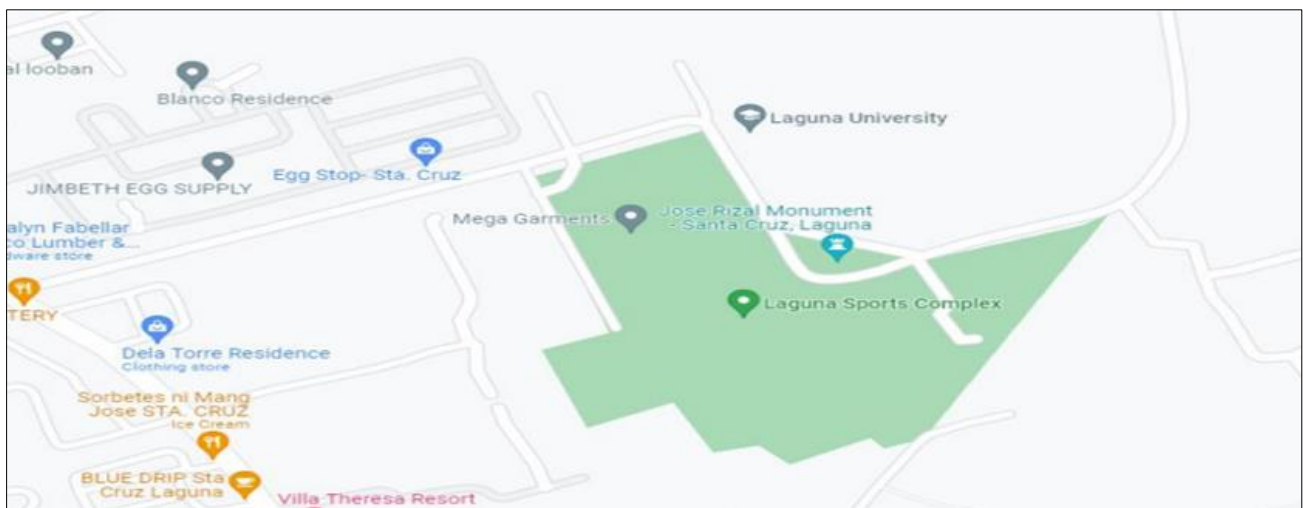


Figure 2 Map of Laguna University

#### 3.3. Population and Sampling Design

Convenience sampling was used to select the respondents from non-probabilistic sampling. A non-probability sampling technique called convenience sampling gathers information from members of the population who are easily available to take part in the study. Selected students of Laguna University were chosen as the target respondents.

#### 3.4. Research Instruments

In gathering the data for evaluating the acceptability of the plant-based biodegradable cups and the commonly used paper cups in terms of appearance, durability, and after taste to the selected students of Laguna University, the researchers used survey questionnaires

#### 3.5. Data Gathering Procedure

The data gathering procedures which include the utilization of the plant-based biodegradable cups of the selected respondents and comparing it with the utilization of the commonly used paper cups. It focuses on the appearance, durability, and aftertaste of warm and cold water, warm and cold calamansi juice, and warm and cold soya milk when consumed from both plant-based biodegradable cups and commonly used paper cups. And lastly, the computing and analyzing of data from the respondents. The computation includes mean and standard deviation with a t-test to find out the level of acceptability of plant-based biodegradable cups and the commonly used paper cups. The results of the computation of the level of acceptability will be used in looking out if there are significant differences between plant-

based biodegradable cups and commonly used paper cups in terms of appearance, durability, and aftertaste. The last section is the analysis and interpretation of the results of the statistical procedures applied to the gathered data to create final conclusion.

### 3.6. Management and Treatment of Data

To analyze and interpret the data, the researcher employed the following statistical procedure.

#### 3.6.1. Mean and Standard deviation

This test was employed to determine the level of acceptability of the plant-based biodegradable cups and the commonly used paper cups in terms of:

- Appearance;
- Durability; and
- After taste

<p><b>Formula:</b></p> $\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$ <p><b>Where:</b></p> <p style="text-align: center;"><math>\sigma</math> = population standard deviation</p>
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N = the size of the population  
 Xi = each value of the population  
 μ = the population mean

#### 3.6.2. T-test

This test was applied to test if there are significant differences between plant-based biodegradable cups and commonly used paper cups in terms of appearance, durability and after taste.

<p><b>Formula:</b></p> $t = \frac{(x_1 - x_2)}{\sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}}$ <p><b>Where:</b></p> <p style="margin-left: 20px;">x1 = mean of sample 1</p> <p style="margin-left: 20px;">s1 = standard deviation of sample 1</p> <p style="margin-left: 20px;">n1 = sample size of sample 1</p> <p style="margin-left: 20px;">x2 = mean of sample 2</p> <p style="margin-left: 20px;">s2 = standard deviation of sample 2</p> <p style="margin-left: 20px;">n2 = sample size in sample 2</p>
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**4. Result and discussion**

**Table 1** The level of acceptability of the plant-based biodegradable cups in terms of Appearance

Statement	Mean	Sd	Remarks
The color of the plant-based biodegradable cup is appealing.	3.97	0.81	Agree
The shape of the plant-based biodegradable cup is good for drinking.	4.30	0.84	Strongly Agree
The texture of the plant-based biodegradable cup is pleasant.	3.90	0.92	Agree
The size of the plant-based biodegradable cup is sufficient for a drinking cup (can hold up to half cup of water)	4.30	0.70	Strongly Agree
Overall Mean = 4.12 Standard Deviation = 0.82 Verbal Interpretation = Acceptable			

Scale	Range	Remarks	Verbal Interpretation
5	4.20 – 5.00	Strongly Agree	Highly Acceptable
4	3.40 – 4.19	Agree	Acceptable
3	2.60 – 3.39	Moderately Agree	Moderately Acceptable
2	1.80 – 2.59	Disagree	Less Acceptable
1	1.00 – 1.79	Strongly Disagree	Not Acceptable

**Table 1** illustrates the level of acceptability of the plant-based biodegradable cups in terms of appearance. Among the statements above, “The color of the plant-based biodegradable cup is appealing” yielded a mean score of (M=3.97 SD=0.81) and was remarked as agree. This is followed by “The shape of the plant-based biodegradable cup is good for drinking.” with the mean score of (M=4.30, SD=0.84) and was also remarked as strongly agree. On the other hand, the statement “The texture of the plant-based biodegradable cup is pleasant” with a mean score of (M=3.90, SD= 0.92) and was remarked as agree and the statement “The size of the plant-based biodegradable cup is sufficient for a drinking cup (can hold up to half cup of water)” received a mean score of responses with (M=4.30, SD=0.70) yet was also remarked strongly agree. Overall, the level of acceptability of the plant-based biodegradable cups in terms of appearance attained a mean score of 4.12 and a standard deviation of 0.82 and was acceptable.

**Table 2** The Level of Acceptability of the Plant-Based Biodegradable Cups in Terms of Durability

Statement	Mean	Sd	Remarks
Plant-based biodegradable cup can endure falling from the height of a regular sized-table.	4.67	0.61	Strongly Agree
Plant-based biodegradable cup can endure forced applied by the user (squishing, tapping, etc.)	4.30	0.75	Strongly Agree
Plant-based biodegradable cup stays intact after using it with hot water (above 45 °C).	4.20	1.03	Strongly Agree
Plant-based biodegradable cup stays intact after using it with cold water (below 10 °C).	4.13	1.04	Agree
Overall Mean = 4.12 Standard Deviation = 0.82 Verbal Interpretation = Acceptable			

Scale	Range	Remarks	Verbal Interpretation
5	4.20 – 5.00	Strongly Agree	Highly Acceptable
4	3.40 – 4.19	Agree	Acceptable
3	2.60 – 3.39	Moderately Agree	Moderately Acceptable
2	1.80 – 2.59	Disagree	Less Acceptable
1	1.00 – 1.79	Strongly Disagree	Not Acceptable

**Table 2** illustrates the level of acceptability of the plant-based biodegradable cups in terms of durability. Among the statements above, “Plant-based biodegradable cup can endure falling from the height of a regular sized-table.” yielded a mean score of (M=4.67 SD=0.61) and was remarked as strongly agree. This is followed by “Plant-based biodegradable cup can endure forced applied by the user (squishing, tapping, etc.)” with the mean score of (M=4.30, SD=0.75) and was also remarked as strongly agree. On the other hand, the statement “Plant-based biodegradable cup stays intact after using it with hot water (above 45 °C)” with the mean score of (M=4.20, SD=1.03) and was also remarked as strongly agree and the statement “Plant-based biodegradable cup stays intact after using it with cold water (below 10 °C)” received the mean score of responses with (M=4.13, SD=1.04) yet was also remarked agree. Overall, the level of acceptability of the plant-based biodegradable cups in terms of durability attained a mean score of 4.33 and a standard deviation of 0.86 and was highly acceptable.

**Table 3** The Level of Acceptability of the Plant-Based Biodegradable Cups in Terms of Aftertaste

Statement	Mean	Sd	Remarks
There is no change in the taste of the cold water when consumed from the plant-based biodegradable cup.	3.73	1.23	Agree
There is no change in taste of the hot water when consumed from the plant- based biodegradable cup.	3.83	1.42	Agree
There is no change in taste of the cold calamansi juice when drank from plant-based biodegradable cup.	4.27	1.05	Strongly Agree
There is no change in taste of the hot calamansi juice when consumed from the plant-based biodegradable cup.	4.03	1.33	Agree
There is no change in the taste of the cold soy milk when consumed from the plant-based biodegradable cup.	4.33	1.06	Strongly Agree
There is no change in the taste of the hot soy milk when consumed from the plant-based biodegradable cup.	4.30	1.06	Strongly Agree
Overall Mean = 4.08 Standard Deviation = 1.19 Verbal Interpretation = Acceptable			

Scale	Range	Remarks	Verbal Interpretation
5	4.20 – 5.00	Strongly Agree	Highly Acceptable
4	3.40 – 4.19	Agree	Acceptable
3	2.60 – 3.39	Moderately Agree	Moderately Acceptable
2	1.80 – 2.59	Disagree	Less Acceptable
1	1.00 – 1.79	Strongly Disagree	Not Acceptable

**Table 3** illustrates the level of acceptability of the plant-based biodegradable cups in terms of aftertaste. Among the statements above, “There is no change in the taste of the cold water when consumed from the plant-based biodegradable cup.” yielded the mean score of (M=3.73 SD=1.23) and was remarked as agree. This is followed by “There is no change in taste of the hot water when consumed from the plant-based biodegradable cup.” with the mean score of (M=3.83, SD=1.42) and was also remarked as agree. Followed by “There is no change in taste of the cold calamansi juice when drank from plant-based biodegradable cup” with the mean score of (M=4.27, SD=1.05) and was also remarked as strongly agree. Followed by “There is no change in taste of the hot calamansi juice when consumed from the plant-based biodegradable cup.” with the mean score of (M=4.03, SD=1.33) and was also remarked as agree. On the other hand, the statement “There is no change in the taste of the cold soy milk when consumed from the plant-based biodegradable cup.” with the mean score of (M=4.33, SD=1.06) and was also remarked as strongly agree and the statement “There is no change in the taste of the hot soy milk when consumed from the plant-based biodegradable cup.” received a mean score of responses with (M=4.30, SD=1.06) yet was also remarked strongly agree. Overall, the level of acceptability of the plant-based biodegradable cup in terms of aftertaste attained a mean score of 4.08 and a standard deviation of 0.19 and was acceptable.



**4.1. The Level of Acceptability of the Commonly Used Paper Cups**

The level of acceptability of the commonly used paper cups in terms of appearance, durability and aftertaste, were treated statistically using mean and standard deviation, as seen on Table 2.

**Table 4** The Level of Acceptability of the Commonly Used Paper Cups in Terms of Appearance

Statement	Mean	Sd	Remarks
The color of the paper cup is appealing.	4.30	1.09	Strongly Agree
The shape of the paper cup is good for drinking.	3.97	1.07	Agree
The texture of the paper cup is pleasant.	4.07	0.94	Agree
The size of the paper cup is sufficient for a drinking cup (can hold up to half cup of water).	3.63	1.25	Agree
Overall Mean = 3.99 Standard Deviation = 1.09; Verbal Interpretation = Acceptable			

Scale	Range	Remarks	Verbal Interpretation
5	4.20 – 5.00	Strongly Agree	Highly Acceptable
4	3.40 – 4.19	Agree	Acceptable
3	2.60 – 3.39	Moderately Agree	Moderately Acceptable
2	1.80 – 2.59	Disagree	Less Acceptable
1	1.00 – 1.79	Strongly Disagree	Not Acceptable

**Table 4** illustrates the level of acceptability of the commonly used paper cups in terms of appearance. Among the statements above, “The color of the paper cup is appealing,” yielded a mean score of (M=4.30 SD=1.09) and was remarked as strongly agree. This is followed by “The shape of the paper cup is good for drinking.” with the mean score of (M=3.97, SD=1.07) and was remarked as agree. On the other hand, the statement “The texture of the paper cup is pleasant.” with the mean score of (M=4.07, SD=0.94) and was remarked as agree and the statement “The size of the paper cup is sufficient for a drinking cup (can hold up to half cup of water)” received the mean score of responses with (M=3.63, SD=1.25) yet was also remarked agree.

Overall, the level of acceptability of the commonly used paper cups in terms of appearance attained a mean score of 3.99 and a standard deviation of 1.09 and was acceptable.

**Table 5** The Level of Acceptability of the Commonly Used Paper Cups in Terms of Durability

Statement	Mean	Sd	Remarks
Paper cup can endure falling from the height of a regular sized-table.	3.27	1.48	Moderately Agree
Paper cup can endure forced applied by the user (squishing, tapping, etc.)	2.00	1.29	Disagree
Paper cup stays intact after using it with hot water (above 45 °C).	3.20	1.30	Moderately Agree
Paper cup stays intact after using it with cold water (below 10 °C).	3.40	1.28	Agree
Overall Mean = 2.97 Standard Deviation = 1.34 Verbal Interpretation = Moderately Acceptable			

Scale	Range	Remarks	Verbal Interpretation
5	4.20 – 5.00	Strongly Agree	Highly Acceptable
4	3.40 – 4.19	Agree	Acceptable
3	2.60 – 3.39	Moderately Agree	Moderately Acceptable
2	1.80 – 2.59	Disagree	Less Acceptable
1	1.00 – 1.79	Strongly Disagree	Not Acceptable

**Table 5** illustrates the level of acceptability of the commonly used paper cups in terms of durability. Among the statements above, “Paper cup can endure falling from the height of a regular sized-table.” yielded a mean score of (M=3.27 SD=1.48) and was remarked as moderately agree. This is followed by “Paper cup can endure forced applied by the user (squishing, tapping, etc.)” with the mean score of (M=2.00, SD=1.29) and was remarked as disagree. On the other hand, the statement “Paper cup stays intact after using it with hot water (above 45 °C)” with the mean score (M=3.20, SD=1.30) and was remarked as moderately agree and the statement “Paper cup stays intact after using it with cold water (below 10 °C)” received a mean score of responses with (M=3.40, SD=1.28) yet was also remarked moderately agree. Overall, the level of acceptability of the commonly used paper cups in terms of durability attained a mean score of 2.97 and a standard deviation of 1.34 and was moderately acceptable.

**Table 6** The Level of Acceptability of the Commonly Used Paper Cups in Terms of After Taste

Statement	Mean	Sd	Remarks
There is no change in the taste of the cold water when consumed from the paper cup.	3.40	1.35	Agree
There is no change in taste of the hot water when consumed from paper cup.	3.27	1.31	Moderately Agree
There is no change in taste of the cold calamansi juice when drank from paper cup.	3.47	1.25	Agree
There is no change in taste of the hot calamansi juice when consumed from the paper cup.	3.57	1.22	Agree
There is no change in the taste of the cold soy milk when consumed from the paper cup.	3.60	1.16	Agree
There is no change in the taste of the hot soy milk when consumed from the paper cup.	3.53	1.11	Agree
Overall Mean = 3.47 Standard Deviation = 1.23 Verbal Interpretation = Acceptable			

Scale	Range	Remarks	Verbal Interpretation
5	4.20 – 5.00	Strongly Agree	Highly Acceptable
4	3.40 – 4.19	Agree	Acceptable
3	2.60 – 3.39	Moderately Agree	Moderately Acceptable
2	1.80 – 2.59	Disagree	Less Acceptable
1	1.00 – 1.79	Strongly Disagree	Not Acceptable

**Table 6** illustrates the level of acceptability of the commonly used paper cups in terms of aftertaste. Among the statements above, “There is no change in the taste of the cold water when consumed from the paper cup.” yielded a mean score of (M=3.40 SD=1.35) and was remarked as agree. This is followed by “There is no change in taste of the hot water when consumed from paper cup.” with the mean score of (M=3.27, SD=1.31) and was remarked as moderately agree. Followed by “There is no change in taste of the cold calamansi juice when drank from paper cup. with the mean score of (M=3.47, SD=1.25) and was remarked as agree. Followed by “There is no change in taste of the hot calamansi juice when consumed from the paper cup.” with the mean score of (M=3.57, SD=1.22) and was remarked as agree. On the other hand, the statement “There is no change in the taste of the cold soy milk when consumed from the paper cup.” with the mean score (M=3.60, SD=1.16) and was remarked as agree and the statement “There is no change in the taste of the hot soy milk when consumed from the paper cup.” received a mean score of responses with (M=3.53, SD=1.11) yet was also remarked agree.

Overall, the level of acceptability of the commonly used paper cups in terms of aftertaste attained a mean score of 3.47 and a standard deviation of 1.23 and was acceptable.

#### 4.2. Test of the Significant Difference between Plant-Based Biodegradable Cups and Commonly Used Paper Cups

In determining the significant difference between plant-based biodegradable cups and commercial disposable cups in terms of appearance, durability, and aftertaste, the data gathered by the researchers were computed electronically using Real Statistic- Data Analysis Tools and treated statistically using T-Test for two-paired Samples.

**Table 7** The Significant Difference between Plant-Based Biodegradable Cup and Commercial Disposable Cup

Plant-Based Biodegradable	Commercial Disposable	T- Stat	P- Value	Interpretation
Appearance		2.40	0.023	Significant
Durability		0.77	0.444	Not Significant
After Taste		5.42	0.000	Significant

\*Significant at  $\alpha=0.05$  As shown on Table 3, the computed p-values difference between plant-based biodegradable cups and commercial disposable cups in terms of appearance and aftertaste are both lower than the level of significance ( $\alpha = 0.05$ ).

On the other hand, the computed p-values difference between plant-based biodegradable cups and commercial disposable cups in terms of durability is higher than the level of significance ( $\alpha = 0.05$ ).

The majority of the p-values are lower than the level of significance; hence, the null hypothesis is rejected. Therefore, there is a significant effect difference between plant-based biodegradable cup and commercial disposable cup in terms of appearance, durability and aftertaste as perceived by the respondents.

#### 5. Summary of Findings

The salient findings of the study were as follows:

- What is the level of acceptability of the plant-based biodegradable cups in terms of:
  - Appearance The level of acceptability of the plant-based biodegradable cup in terms of appearance attained a mean score of 4.12 and a standard deviation of 0.82 and was acceptable
  - Durability The level of acceptability of the plant-based biodegradable cups in terms of durability attained a mean score of 4.33 and a standard deviation of 0.86 and was highly acceptable.
  - Aftertaste The level of acceptability of the plant-based biodegradable cups in terms of aftertaste attained a mean score of 4.08 and a standard deviation of 0.19 and was acceptable.
- What is the level of acceptability of the commonly used paper cups in terms of:
  - Appearance The level of acceptability of the commonly used paper cups in terms of appearance attained a mean score of 3.99 and a standard deviation of 1.09 and was acceptable.
  - Durability The level of acceptability of the commonly used paper cups in terms of durability attained a mean score of 2.97 and a standard deviation of 1.34 and was moderately acceptable.
  - Aftertaste The level of acceptability of the commonly used paper cups in terms of aftertaste attained a mean score of 3.47 and a standard deviation of 1.23 and was acceptable.

Is there a significant difference between plant-based biodegradable cups and commonly used paper cups in terms of appearance, durability and aftertaste?

The majority of the p-values are lower than the level of significance; hence, the null hypothesis is rejected. Therefore, there is a significant difference between plant-based biodegradable cups and commonly used paper cups in terms of appearance and aftertaste; on the other hand, durability showed no significant difference between the plant-based biodegradable cups and the commonly used paper cups according to the results of the t-test for two paired test.

#### 6. Conclusion

Based on the findings of the study, the following conclusions were drawn:

- The researchers concluded that the level of acceptability of the plant-based biodegradable cups in terms of appearance, durability and aftertaste was a potential to be an alternative to commonly used paper cups but needed enhancement in appearance and aftertaste.

- The researchers concludes that the level of acceptability of the commonly used paper cups in terms of appearance, durability and aftertaste are still efficient as drinking cups.
- The researchers concludes that there is a significant difference between plant-based biodegradable cups and commercial disposable cups in terms of appearance and aftertaste and there is no significant difference in terms of durability as perceived by the respondents

### *Research and Policy Recommendations*

Based on the findings and conclusions presented, the following recommendations are suggested:

- The researchers recommend improving the size and shape of the plant-based biodegradable cups by having bigger equipment in baking and more effective molders.
- The researchers recommend finding an effective substitute to agar which will improve the taste effect and appearance concerning texture of the plant-based biodegradable cup.
- The researchers recommend further study that will prove the safeness of the plant-based biodegradable cup for consuming substances being held by it.
- The researchers recommend further study that will identify the marketability of the plant-based biodegradable cup.

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### **Compliance with ethical standards**

#### *Disclosure of Conflict of interest*

All authors do not have any conflict of interest to declare.

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