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UTILIZING CASSAVA STARCH AND POWDERED RICE BRAN IN MAKING BIODEGRADABLE STRAWS

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Abstract

Numerous agricultural wastes are impractically discarded every day, and one of these is rice bran. This study investigated the production of a biodegradable straw made of cassava starch and powdered rice bran. It aimed to determine the effectiveness of the different treatments of Cassava Starch-Rice Bran in terms of water resistance, tensile strength, and biodegradability. An experimental design was used in conducting the study. There were three treatments made in making CSRB straws: the first, with more rice bran; the second, with the same cassava starch and rice bran ratio; and the third, with more cassava starch. These treatments produced three replicates each. The straws were placed in a dehydrating machine for 24 hours at a temperature of 60° Celsius. The straws were then coated with beeswax after being removed from their respective molders. The CSRB straws were found to be water resistant due to the beeswax coating applied, although it had a weak tensile strength even with the presence of beeswax. The rate of biodegradability of the CSRB straw was fast due to it being made up of organic materials. The results revealed that straws made from Cassava Starch and Powdered Rice Bran are effective in terms of water resistance and biodegradability.

Keywords: *CSRB-Straw, Water Resistance, Biodegradability, Tensile Strength*

INTRODUCTION

Plastic is a widely used material in today's era. It is commonly used as a container for solids and liquids. However, it is also used to make vehicle parts, appliances, and objects that humans use to make their lives easier and more efficient. According to the History and Future of Plastics (2019), plastic being categorized as an easily shaped material is the main reason it is utilized to make objects for people to use. However, after using plastic products, the problem follows. Plastic products' rapid production resulted in difficulties in disposing of these objects, especially since they take years to decompose (Parker, 2021).

Plastic products are not only used for food, shelter, and clothing but also in construction, medical uses, and different industries (Taguchi et al., 2012). According to Parker (2021), plastic products, namely plastic straws, are unnecessary objects in beverage consumption. Plastic straws are made using fossil fuels. Plastic straws are rarely recycled because they are too small and are made from different kinds of plastic (Prisco, 2018). The rate of usage of plastic straws is hard to measure because of its size one of the factors. Still, it is one of the most widespread kinds of litter. According to Litterati (2017), an application that identifies trash, plastic straws place sixth worldwide as the most common type of litter.

Additionally, chemical components from the breakdown of plastics harm the environment. Based on the Visual Feature (2022), plastic has been produced at a quicker rate than any other material since the 1970s. By 2050, it is anticipated that the world's primary plastic production will have increased by 1,100 million tons. Even though a plastic straw is small, it still has a negative impact on the environment because it undergoes breakdown, which produces harmful chemicals. According to Panageas (2019), polypropylene is a chemical that is a byproduct of petroleum. This chemical is present when plastic straws undergo breakdown. Polypropylene is the same chemical found in gasoline that does not decay in the environment, resulting in the polypropylene consumed by animals.

Due to the demand for global plastic consumption, a lot of research is being dedicated to exploring the possibility of using renewable materials and new ways of processing them (Ashter, 2016). A lot of research was done on bioplastic production, and one green material found to be useful in its production is starch. The amylose content present in starch is important in bioplastic production as it is significant in gelatinization and retrogradation during film formation (Santana et al., 2018). Also, starch can be easily extracted from starchy foods, which makes it sustainable and efficient. In this research, the researchers will propose another alternative for plastic making, which is the utilization of powdered rice bran. In developing countries, rice bran is considered waste or agricultural waste (Sharif et al., 2014).

Agricultural waste is any material that comes entirely from unwanted agricultural operations. It comes from growing crops or raising livestock (Agricultural Waste, n.d.). During the last 50 years, in order to keep up with the fast-growing population, agricultural intensification has been the primary factor in a more than threefold increase in food supplies (Strategic Work of FAO for Sustainable Food and Agriculture, 2017). Consequently, as the production of agricultural needs increases, the number of agricultural wastes also increases. The methods of disposal for these agricultural wastes are burning, dumping, landfilling, haphazard piling, and other ways frequently used to dispose of agricultural waste. All these techniques can lead to pollution (Organic fertilizers plants, 2020). One of the most well-known techniques of agricultural waste disposal is burning. This technique is usually seen being done on rice husks in the middle of a rice field. According to Silica from rice husk ash (2011), rice husk is a readily available agricultural waste that contains a significant amount of siliceous ash. RHA is composed of 85–98% silica when rice husks are burned in the air. Burnt rice husks pollute the environment and represent a health risk.

As mentioned, there is an existing problem with the production and disposal of plastics, as well as problems with agricultural waste. Hence, in order to address the problems, the researchers utilized cassava starch and powdered rice bran, an agricultural waste commonly found in the Municipality of Midsayap, in making biodegradable straws. The researchers in this study explored the possibility of creating straws that are fit for everyday use, which were tested in terms of water resistance, tensile strength, and biodegradability.

Single-use plastic straws have become a significant environmental concern due to their negative impact on the environment, particularly on marine life and ecosystems. For example, plastic straws cause health problems for sea turtles when the straws get stuck in their stomachs and noses (Fox, 2022). As a result, there is a growing demand for sustainable alternatives to traditional plastic straws that are biodegradable and eco-friendly.

One promising solution is the utilization of cassava starch and powdered rice bran to create biodegradable straws. Cassava starch is a renewable and abundant source of starch that can be extracted from the cassava root, which is widely grown in tropical and subtropical regions. Powdered rice bran, on the other hand, is a byproduct of rice milling process that is often discarded, but contains valuable nutrients and fibers.

People use rice bran to decrease the body's absorption of cholesterol and calcium and prevent kidney stone formation. However, no substantial evidence supports these uses (RICE BRAN: Overview, Uses, Side Effects, Precautions, Interactions, Dosing and Reviews, n.d.). However, powdered rice bran is widely used for food consumption. For example, rice bran is commonly used as feed for animals (Huang et al., 2018). It is also used as the main ingredient for some cereals (Sharif et al., 2014).

On the other hand, the food sector uses cassava starch with a relatively high amylopectin content due to its high paste clarity, the cohesive texture of pastes, low tendency for retrogradation, and good gel stability (Karam et al., 2005). To generate cassava starch, its fibrous components must be extracted, after which they can be used as a food-sticking agent.

The combination of cassava starch and powdered rice bran has the potential to create biodegradable straws with desirable properties. Cassava starch provides the necessary structural integrity and flexibility, while powdered rice bran can enhance the mechanical strength and reduce the brittleness of the straws. Additionally, both cassava starch and powdered rice bran are biodegradable, renewable, and do not contribute to environmental pollution.

The utilization of cassava starch and powdered rice bran in making biodegradable straws has several potential benefits. Firstly, it offers a sustainable alternative to traditional plastic straws, reducing the environmental impact associated with plastic waste. Secondly, it can provide a valuable use for cassava starch and powdered rice bran, which are abundant agricultural byproducts that might otherwise go to waste. Thirdly, it has the potential to promote local economic development by utilizing locally available resources and creating new market opportunities for cassava and rice bran producers. This means that not only can it significantly contribute to the reduction of the negative impacts of plastic waste, but it can also become a livelihood for people who are living in areas abundant with powdered rice bran and cassava starch.

Despite these potential benefits, there is limited research on the utilization of cassava starch and powdered rice bran in making biodegradable straws. Further studies are needed to explore the optimal formulation, processing techniques, and properties of cassava starch and powdered rice bran-based straws. This research aims to address this gap by investigating the feasibility and performance of utilizing cassava starch and powdered rice bran in making biodegradable straws, with the goal of contributing to the development of sustainable alternatives to single-use plastic straws

Objectives

This study utilized Cassava Starch and Powdered Rice Bran in producing biodegradable straws. Specifically, this study sought to:

1. Use cassava starch and powdered rice bran in making Cassava Starch-Rice Bran (CSRB) biodegradable straw.

2. Determine the effectiveness of using cassava starch and powdered rice bran making Cassava StarchRice Bran (CSRB) biodegradable straw in terms of:
   a. water resistance,
   b. tensile strength, and
   c. biodegradability;

3. To determine if there is a significant difference in the treatments of the Cassava Starch-Rice Bran (CSRB) biodegradable straw in terms of:
   a. water resistance,
   b. tensile strength, and
   c. biodegradability;

METHODS

Research Design

This study employed quantitative experimental research because it included collecting and analyzing numerical data to determine the solutions to the problems that are present in the study. Additionally, this study also used an experimental research design to explore the numerous processes and procedures that were conducted to utilize cassava starch and powdered rice bran in making Cassava Starch-Rice Bran (CSRB) biodegradable straws. This design gave emphasis on the different results after manipulating the dependent variables and independent variables of the study.

Population and Sampling

In this experimental study, the respondents were the researchers themselves. This is because the researchers were the ones to conduct a series of tests that were used to determine the effectiveness of Cassava Starch-Rice Bran (CSRB) biodegradable straws. Each of the respondent researchers rated the CSRB biodegradable straw in terms of water resistance, tensile strength, and biodegradability. Moreover, any forms of bias were avoided by the researchers in conducting the study.

Instrumentation

This study used observation and tally sheets. The researchers collected all the information derived from observations and then recorded all the findings on the tally sheet. The recorded data underwent analysis and evaluation to see whether cassava starch and powdered rice bran are effective in making Cassava Starch-Rice Bran (CSRB) biodegradable straws and if it satisfied the expected result of this experimental study, specifically the objectives.

Data Collection

The researchers conducted different tests in order to gather data that will prove the effectiveness of cassava starch and powdered rice bran in making Cassava Starch-Rice Bran (CSRB) biodegradable straw. The data were gathered, collated, tabulated, and subjected for statistical treatment. The results of the different tests conducted were the basis of the researchers in determining the effectiveness of the crafted material.

Data Analysis

The data were collected from the tally sheets. Descriptive statistics were used to determine the effectiveness of the Cassava Starch-Rice Bran (CSRB) biodegradable straw using the mean and standard deviation. One-way ANOVA was used to determine the significant difference between the treatments of the study in terms of water resistance, tensile strength, and biodegradability.

RESULTS and DISCUSSION

Table I. Mean and Interpretation of the Different Treatments of CSRB Biodegradable Straw in Terms of Water Resistance.

Treatments	Mean	SD	AVG Weight Increase in %
T1	0.24	0.066	1.45%
T2	2.39	1.55	19.97%
T3	0.60	0.46	4.73%

Table I shows the mean of the weight gain of the different replicates per treatment. In this specific test, the researchers found out that a lower mean weight increase means a low average weight increase in percent and higher water resistance. Treatment 1 has the lowest mean of 1.45%; therefore, it has better water resistance compared to the other treatments. On the other hand, Treatment 2, which has the greatest mean of 19.97%, is inferior in terms of water resistance among all three treatments. All treatments are considered water resistant as they were able to maintain a small increase in weight. The presence of beeswax, a lipid-rich water-repellent substance known for its strong hydrophobicity (lewkittayakorn et al, 2020), as well as the plastic properties of the CSRB biodegradable straw because of glycerin greatly helped in minimizing the weight increase even after being submerged in cold water for 2 hours making the treatments resistant to water.

Table II. Mean and Interpretation of the Different Treatments of CSRB Biodegradable Straw in Terms of Tensile Strength.

Treatments	Mean	SD	Interpretation
T1	83.33	57.74	Less tensile
T2	116.67	57.74	Less tensile
T3	83.33	57.74	Less tensile

Legend:

		Interpretation
1 g – 125 g	-	Less tensile
126 g – 250 g	-	Slightly less tensile

251 g – 375 g	-	Slightly high tensile
376g and above	-	Highly tensile

Table II shows the results of the tensile strength test. During the conduct of the test, both Treatment 1 and Treatment 2 were able to withstand a total mean weight of 83.33 grams, while Treatment 3 was able to resist a total mean weight of 116.67 grams before bending. Using the Likert Scale, all treatments are considered less tensile because they were only able to withstand a total weight that is included in the 1 gram to 125 grams interval. This interpretation may be related to the overall composition of the CSRB biodegradable straw. The cassava starch, beeswax, and rice bran were not enough to endure a greater amount of pressure for long periods. Also, the thickness of the straw and the amount of beeswax present are factors that affect the tensile strength of CSRB biodegradable straws.

Table III. Mean and Interpretation of the Different Treatments of CSRB Straw in Terms of Biodegradability

Treatments	Observation 1	Observation 2	Observation 3	Mean	SD
T1	3.2	2.3	0.81	2.10	0.24
T2	2.23	1.8	0.64	1.55	0.22
T3	1.25	1.96	1.44	1.55	0.47

Table III shows the decrease in weight of the three treatments in three observations. It shows that there is a steady weight decrease happening between the treatments. In the study of Nissa et al., (2019), the Soil Burial Test was utilized to determine the biodegradability of a certain material depending on the decrease in weight. A high mean in weight decrease of the straws means a high performance in terms of biodegradability. Therefore, all treatments were able to possess biodegradable properties as they were observed to have a decrease in weight every after observations.

According to Smith and Smith (2012), carbon is the backbone of life on Earth, decomposer organism obtains their energy by oxidation of the carbon compounds. The CSRB biodegradable straw is an organic material that is mainly composed of carbon compounds; hence, it easily decomposes when exposed to organisms and other factors such as moisture and temperature when buried underground. The composition of the CSRB biodegradable straw as well as the observed decrease in weight is a strong indication that it is indeed biodegradable.

Table IV. One-way Analysis of Variance of the Water Resistance of the CSRB Biodegradable Straw

Treatments	Mean	SD	P-Value	F-Ratio	Decision
T1	0.24	0.066			
T2	2.39	1.55			
T3	0.60	0.46	0.0623**	4.5685	Accept Ho_1

****significant at α = 0.05**

Table IV shows the different data needed to determine if there is a significant difference between the three treatments. Based on the calculations shown above, the three treatments have a p-value of 0.0623 and an F-ratio of 4.5685. There is no significant difference between the three treatments because the p-value is greater than the alpha value or is not significant at α = 0.05; therefore, accepting Ho_1 which states that there is no significant difference in the different treatments of the CSRB biodegradable straw. This suggests that even though there are treatments that have a higher or lower mean compared to the others, there is still no significant difference among them. All the treatments are statistically the same in terms of water resistance. The presence of beeswax on all treatments made all of them water-resistant, which means that choosing one treatment over the other for drinking is meaningless as they all have the same performance in terms of water resistance. The different amounts of ingredients per treatment were not enough to make a significant difference between the three treatments of the study in terms of resisting contact with water.

Table V. One-way Analysis of Variance of the Tensile Strength of the CSRB Biodegradable Straw

Treatments	Mean	SD	P-Value	F-Ratio	Decision
T1	83.33	57.74			
T2	116.67	57.74			
T3	83.33	57.74	0.7290**	0.3333	Accept Ho_2

****significant at α = 0.05**

Table V shows the different data needed to determine if there is a significant difference between the three treatments. Based on the calculations shown above, the three treatments have a p-value of 0.7290 and an F-ratio of 0.3333. There is no significant difference between the three treatments because the p-value is greater than the alpha value or is not significant at α = 0.05; therefore, accepting Ho_2 which states that there is no significant difference in the different treatments of the CSRB biodegradable straw in terms of tensile strength. This means that all treatments have equal performance in terms of tensile strength. Even though the treatments have different mean scores, those were statistically not significant making the CSRB straw to have no difference from each other. As mentioned previously, the composition of the CSRB straw is not enough to withstand heavy weights for a long period of time; hence, all the treatments are less tensile as interpreted using the Likert Scale. No matter what treatment is chosen, there will be no difference because the different ratios of ingredients per treatment have little to no impact on the tensile strength of the treatments.

Table VI. One-way Analysis of Variance of the Biodegradability of the CSRB Biodegradable Straw

Treatments	Mean	SD	P-Value	F-Ratio	Decision
T1	2.10	0.24			
T2	1.55	0.22			
T3	1.55	0.47	0.1352**	2.8449	Accept Ho_3

****significant at α = 0.05**

Table VI shows the different data needed to determine if there is a significant difference between the three treatments. Based on the calculations shown above, the three treatments have a p-value of 0.1352 and an F-ratio of 2.8449. There is no significant difference between the three treatments because the p-value is greater than the alpha value or is not significant at α = 0.05; therefore, accepting Ho_3 which states that there is no significant difference in the different treatments of the CSRB biodegradable straw in terms of tensile strength. This suggests that all the treatments regardless of the ratios of ingredients used are considered statistically the same; therefore, have the same level of biodegradability. All the treatments are considered organic, and organic materials degrade easily. Even in the presence of beeswax and having different mean scores, all treatments are equal in biodegradability as presented using the analysis. Choosing different treatments to be tested will have the same results because all treatments of CSRB biodegradable straw, despite having different measurements in ingredients, have no difference in terms of biodegradability.

CONCLUSIONS

The results of the study prove that cassava starch and powdered rice bran could be utilized to make biodegradable straws. Based on the purpose, objectives, and results of the study, the following conclusions were made:

1. All three treatments of the CSRB biodegradable straw are effective in terms of water resistance. All three treatments are highly resistant to water and there are no significant differences among the three treatments. The beeswax and the plastic properties of the straw brought by the plasticizer are among the major factors that affect the overall quality and performance of the CSRB biodegradable straw in terms of water resistance.

2. All three treatments of the CSRB biodegradable straw exhibited unsatisfactory results in terms of tensile strength. All three treatments are considered less tensile and there are no significant differences among them, which can be drawn out from the fact that it is all composed of organic material and is lacking in thickness.

3. All three treatments of the CSRB biodegradable straw are effective in terms of biodegradability. They are all biodegradable as observed in the decrease in weight, and there were no significant differences found between the three treatments. The composition of the CSRB biodegradable straw as organic material is the main reason why it decomposes easily.

4. The different treatments of CSRB biodegradable straw are effective in terms of water resistance and biodegradability; however, it is ineffective in terms of tensile strength. Overall, despite being proven ineffective in carrying greater amounts of weight, the research was still able to achieve its major purpose and objective. The researchers were able to create biodegradable straws using cassava starch and rice bran that was tested in terms of water resistance, tensile strength, and biodegradability.

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