

The background features a pattern of small green dots on a white background, with larger, semi-transparent green geometric shapes (squares and triangles) overlaid. The text is centered and framed by two horizontal green lines.

# **POSTER PRESENTATION**



## Online Distance Learning in Baras-Pinugay: Grade 11 HUMSS & TVL Students' Challenges and Opportunities

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**Abstract:** The COVID-19 pandemic forced government officials to declare a state of emergency in the Philippines. The Department of Education (DepEd) strived for an efficient way to bring knowledge to students even without face-to-face classes. DepEd proposed online distance learning (ODL), whereby classes will be conducted remotely using online platforms. While most studies in the Division of Rizal focused on the teaching strategies, effectiveness of modular distance learning, research guide in the new normal (Andres, Discutido, & Martos, 2020; Caezar & Parungao, 2020; Robles & Miranda, 2020), no study has explored the challenges, issues, and possible opportunities among ODL students. Hence, this paper attempted to qualitatively investigate the challenges and opportunities of the said learning modality among SHS students. A total of ten Grade 11 students from HUMSS and TVL strands were conveniently (Barrot, 2018) selected as participants of the study. Online semi-structured interview was done to collect data. Findings provided an overview of trials and prospects of students' experiences in ODL based on the six major themes developed. Implications for teachers were also drawn from this study.

**Key Words:** COVID-19 pandemic; Department of Education; new normal in education; online distance learning; senior high student

### 1. INTRODUCTION

The fight against the new coronavirus pandemic has led to profound effects on almost all sectors of human society. This includes widespread interruption such as travel restrictions (Chinazzi, et al. 2020), global economic recession (Fernandes, 2020), misinformation and controversies (Enitan, Ibeh, Oluremi, Olajanyu, & Itodo, 2020) to name a few. Responses like lockdown and community quarantine have led students and teachers to study and work at home using online platforms.

In the Philippines, Mateo (2021) mentioned in his article that government officials had immediately suspended the traditional face-to-face classes with the threat of high transmission among students during early 2020. The Department of Education had set an alternative learning modality (Briones, 2020), whereby teaching is undertaken remotely and on digital platforms.

Due to the uncertainty brought by the pandemic, the use of available technical resources to facilitate online distance learning (ODL) has become one of the solutions. Thus, a sudden transformation of classroom instruction might happen in School Year 2020-2021, as Javier (2020) mentioned in his essay.

With the advancement of technology, ODL becomes feasible. For synchronous sessions, teachers are using free online applications like Google Meet

and Zoom. While for asynchronous sessions, they use Facebook groups, Google classroom, Edmodo, and others.

Nevertheless, ODL has its limitations, including unstable internet connection and unsatisfactory digital skills of students. Some benefits, such as flexibility, can also be a limitation, especially for students working at the same time.

While most studies in the Division of Rizal focus on the teaching strategies, the effectiveness of modular distance learning, and research guide in the new normal (Andres, Discutido, & Martos, 2020; Caezar & Parungao, 2020; Robles & Miranda, 2020; Sacramento, Ibañez, & Magayon, 2020), no studies have investigated the challenges, issues, and possible opportunities happening amongst students.

This research aims to adequately understand the students' circumstances and opportunities under the ODL format. Strengthening the practices in the new learning setup is a concern to make it more responsive to the learning needs of students. Hence, this study provides an overview of the effects of online learning among students to provide classroom teachers recommendations on enhancing the implementation of ODL.



### 1.1 Research Questions

1. What are the challenges and difficulties faced by Grade 11 HUMMS and TVL students during ODL?
2. What are the opportunities these SHS students have during ODL?

## 2. METHODOLOGY

### 2.1 Research Design

The study aims to understand the student challenges, difficulties, and opportunities while in ODL. The study used a directed approach of content analysis by Hsieh and Shannon (2005) to validate or extend conceptually the themes from the interviews. The data was collected through online semi-structured interviews, with open-ended questions, to explore the participants' experiences.

### 2.2 Sampling

A total of ten Grade 11 HUMSS and TVL students participated in the study. They were divided into two groups, five from the Humanities and Social Sciences (HUMSS) and five from the Technical-Vocational-Livelihood (TVL). Barrot's (2018) convenience sampling technique was used considering the voluntary nature of the study. These Grade 11 students who are officially enrolled in Baras-Pinugay Integrated High School for the School Year 2020-2021 were considered in the study because (1) the said grade level has only two strands; and (2) they have the most active number of students attending ODL.

### 2.3 Data Collection

The interviews were conducted virtually since face-to-face interactions were prohibited based on the Inter-Agency Task Force (IATF) guidelines. The participants were scheduled for the interview based on their availability. This is to ensure the time-on-task policy of the department.

### 2.4 Data Analysis

The study was guided by Hsieh and Shannon's (2005) directed content analysis; hence challenges and opportunities that were beyond the principles were still noted for possible extended findings for the study. A teacher who has been teaching for almost eleven years and an early career researcher served as the intercoder for this work. In addition, the help of an intercoder, who validated the analysis of the interview transcripts, was sought to guarantee the validity, reliability, and quality of the results..

## 3. RESULTS AND DISCUSSION

### 3.1 The Challenges and Difficulties faced by Grade 11 HUMMS and TVL Students in Online Distance Learning

#### 3.1.1 On Students' Internet Stability

It is crucial to have an internet stable enough to support the online learning of students. However, most of the participants revealed having a hard time when it comes to internet stability. Since ODL is conducted virtually, students face challenges due to the unstable internet. In fact, four out of five participants from TVL and two out of five participants from HUMSS claimed that an unstable connection makes it difficult to understand the lessons being discussed.

*TVL Student E: "I cannot clearly understand the lessons because of the intermittent sound and voice. I missed an online class because of the unstable internet as well, sometimes no internet at all. This is making it hard to attend online classes via Google Meet."*

In the above extract, the participant expressed struggles in understanding the lessons taught in online classes.

*TVL Student C: "The connection is very unstable because we can't keep up with the lesson and sometimes our account automatically leaves Google Meet."*

Similar to the first extract, the participant struggled in coping with the lessons due to internet issues.

#### 3.1.2 On External Barriers

Learning is better with a good environment. Four out of five TVL participants and three out of five participants in HUMSS revealed difficulties when studying because of distractions in their environment, noise specifically.

*HUMSS Student D: "Because of the loud barking of the dog, the shouting, and the high-volume radio of our neighbor, sometimes I could not understand what our teacher was saying."*

*TVL Student D: "Noises are a big disadvantage especially when children are playing in front of our house, I am not able to hear the discussion of my teachers so sometimes I can't understand it at all."*

Participants had trouble understanding the teacher's discussion due to noise from the neighborhood, including barking of dogs, high volume of radio, people shouting, and children playing in the street.

*HUMSS Student C: "Outside nuisance can really be troublesome especially with synchronous activities"*



*since it is live. The background noises can ruin your focus in the lesson.”*

The participants had trouble due to external barriers, and these affected their focus in class.

### 3.1.3 On Lack of Parental Support

With the significant shift in the academic setting, it must be imperative for students to have parental support in their studies since this is significantly related to academic achievement (Javier & Jubay, 2019). There is an agreement between the participants regarding the necessity for parental support. Data from four out of five TVL participants and four out of five HUMSS participants revealed how parental support affects their learning.

*HUMSS Student A: “If parents will not support their children with their education, the student might lose his or her motivation causing them to neglect their responsibility.”*

*HUMSS Student C: “I think if your parents won’t support you, you’ll lose your inspiration and motivation in doing your activities.”*

*TVL Student C: “It is quite difficult to study without parent’s support as this adds to the problem of a student that may result for him/her to stop studying.”*

In the extracts, the participants perceived lack of parental support as a factor adding to students’ stress. Parental support is necessary for a student’s motivation and prevents a student from neglecting their responsibility.

## 3.2 The Opportunities of SHS Students in Online Distance Learning

### 3.2.1 On Comfortability

Despite having drawbacks, the brighter side of ODL is that it provides comfortability among students, away from the danger caused by the global pandemic.

*HUMSS Student E: “It is better because it is quiet, I am able to answer my tasks thoroughly and am not rushed.”*

Since classes are conducted virtually, students are not obliged to finish their tasks within the day and after each class, they can easily loosen up. This gives them more opportunity to thoroughly execute their tasks.

*HUMSS Student C: “At first it was awkward, answering with my parents listening but as time went by, I got used to it and it is much more comfortable now.”*

*HUMSS Student D: “I’m having a hard time because I’m not used to this kind of study but as time goes on, I’ve been enjoying it.”*

Within the comfort of the learner’s home, their parents can freely observe their learning ability, boosting their performance academically.

### 3.2.2 On Affordability

Online learning is more cost-efficient compared to physical learning. Online learning eliminates the cost points of student transportation, student meals, and most importantly, real estate (Gautam, 2020). Students do not need to pay for unnecessary things such as transportation fares. Learners can easily access their lessons and with the paperless submissions for their activities, it is highly evident that online learning is much more affordable.

*TVL Student E: “Face-to-face classes cost much more than online class. You do not have to spend much now that you are at home. I also do not need to spend for buying notebooks for different subjects.”*

*TVL Student C: “ODL is cost-efficient because my parents don’t need to spend for my expenses (allowance, lunch, snacks, etc.) because I am studying at home.”*

It shows that ODL can also cut the cost for students like travel expenses, allowance, food, and others. This allows their parents to allocate the intended budget for the expenses to other household needs.

Online learning cuts most of the costs needed for physical learning, making it more cost-effective for the student’s family.

### 3.2.3 On Time-Management

With flexibility comes the need for students to prioritize their time accordingly (Best, 2020). ODL promotes student’s responsiveness when it comes to managing their time for future purposes too.

Students’ schedules are flexible, giving them the accountability for their time. It molds the student’s ability to organize what they need to do next to efficiently make use of their allotted time.

They are free from the obligations of studying at a specific time, but this raises their awareness of doing their responsibility as a student naturally.

*TVL Student C: “I do not need to wake myself early just to prepare stuff and go to school, I only need to prepare myself and my device for online class. I can freely manage my time as well because there is allotted time for online classes. I can spend my remaining time doing household chores and other things. I can also synchronize doing household chores and attend my class too.”*

*TVL Student E: “I can do house chores after my classes online, sometimes I am able to do my house chores and online classes at once. I can manage my time more effectively unlike in the face-to-face classes.”*



Because of ODL, some students can even multitask. Learners are allocating specific time to study based on their own preferences, making their performance better.

*HUMSS Student A: "Now that I can control my own time when it comes to studying and doing household chores, it is much easier for me to move and decide what I should do next."*

With ODL as a learning modality, students systematically decide what they will do for a single day, making them more progressive and efficient.

#### 4. CONCLUSIONS

The educational landscape is highly affected by the COVID-19 pandemic. In the Division of Rizal, this study presented some of the new normal situations in the school setting. Students are experiencing problems in ODL, but they see a silver lining amidst these issues. Teachers are encouraged to extend understanding because students are still coping with the changes in the new normal.

Classroom teachers must tailor-fit their online instructions to meet the needs of diverse students, even though there are challenges on how to provide and deliver quality education amidst exceptional times. Localized and contextualized online instructions will make learning engaging and meaningful among students.

The study has limitations since it only surveys a few participants and focuses only on ODL students in consideration of the COVID-19 pandemic. It is suggested that future studies in line with ODL should have more participants and do quantitative research using the themes generated in the current study to obtain more data that will help teachers and school administrators revisit and recalibrate the current School Learning Continuity Plan.

This present study hopes to shed light on the issues and challenges of ODL students which will help schools improve the delivery of ODL. Finally, this study gives significant input to some of the lived experiences of students during the pandemic.

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## The Effect of Using Exoskeleton of Blue Crab (*Callinectes sapidus*) as a Dietary Calcium Source on the Egg Characteristics of Layer Hens (*Gallus gallus domesticus*)

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**Abstract:** The study focuses on the ability to use the exoskeleton of blue crab as alternative calcium and carotenoid supplement for layer hens and its effects on egg characteristics. Three groups of eighty layer hens each were fed a base feed formulation following the standards of the University of the Philippines Los Baños. The feeds were base feed as negative control (NG), a base feed with natural egg yolk colorants (capsorubin and lutein) as positive control (PG), and a base feed with 1% ground blue crab exoskeletons, as experimental (EG). The feeding lasted four weeks before egg collection. The eggs were weighed for their albumen, yolk, shell, and egg weight. The egg yolk color was determined using a DSM Fan and a digital Chroma meter, and the shell thickness using digital calipers. Statistical treatment was done through Kruskal Wallis test using SPSS software. Results showed that eggs of EG had significantly heavier shells with a mean of  $5.93 \pm 0.11$ g, compared to  $5.83 \pm 0.08$ g of the NG and  $5.55 \pm 0.08$ g of the PG. Eggshell thickness was not significantly different among the three groups. Egg yolk color was significantly different in PG with a mean DSM gradient value of  $11.96 \pm 0.11$ , compared to  $5.92 \pm 0.14$  of the NG and  $6.48 \pm 0.20$  of EG. Ground blue crab exoskeleton as a calcium supplement may increase the weight of the eggshells but may not intensify the egg yolk color.

**Key Words:** Layer hens; calcium; carotenoid; crab; egg

### 1. INTRODUCTION

According to the Philippine Statistics Authority (2019), egg production has grown, at the highest rate of increase, by 43.4% from January 2019 to March 2019. The industry has produced 142.01 metric tons of eggs from January to March of 2019, as opposed to the 130.55 metric tons of eggs produced in the same months of the previous year.

Layer hens (*Gallus gallus domesticus*) are domesticated chickens bred specifically for the production of eggs. According to the Philippine Statistics Authority (2019), as of July 2019, there are 40.4 million-layer hens in inventory. The feeds consist of raw ingredients which contain the nutritional requirements of laying hens. These include sources of energy and carbohydrates, protein, vitamins, minerals, and oils (PHILSAN, 2003).

For layer hens, a key component of their feeds is the mineral source, specifically calcium. Calcium increases the quality of the egg in terms of its shell. With its increasing demand for feeds, the layer hen industry varies in sources of calcium, such as limestone grits and limestone fines. The average commercial feed supplemented with calcium carbonate grit usually has sufficient calcium, phosphorus, manganese, and vitamin D to produce sound shells (Ahmadi et al., 2011).

Egg yolk color is also an essential parameter of egg quality. There are egg yolk colorants, which act as a feed component to intensify or modify the color of egg yolks from chickens that consume them. The number of egg colorants added on feeds is vital because, according to Zaheer (2017), the yolk color is "largely dependent on hen's feed composition." The yolk color is important to consumers' acceptability because a richer-colored yolk meant a healthier and more nutritious egg since the hen's diet came from natural pigments (Severson, 2020). Some egg colorants are capsorubin and lutein, making the egg yolk slightly darker and lighter, respectively. Capsorubin is a natural pigment found in chili peppers, which coexists with capsaicin to provide dark red colors. It is an excellent source of vitamin A and contains dietary fiber, vitamin E, B6, and folate (Hassan et al., 2019). On the other hand, Lutein is a natural pigment in vegetables, which gives them their bright, yellow pigment (Zaheer, 2017).

This study used *Callinectes sapidus*, commonly known as blue crabs, widely used for human consumption. The study utilized the exoskeleton of *C. sapidus* since this is being discarded and considered as factory waste after the meat from this crab is extracted and manufactured into other food products.



The exoskeleton of a blue crab covers almost all parts of its body and consists of multiple components, including calcium carbonate (CaCO<sub>3</sub>), estimated to comprise 27.5% of the total exoskeleton. This may make it a viable source of dietary calcium for layer hens. In line with this, the study aimed to assess if using crab exoskeleton as a dietary calcium source may increase the hardness and thickness of layer hen eggshells. The crab exoskeleton also contains carotenoids, which may modify the egg yolk color.

Proximate analysis is a standardized series of tests to feed to determine crude protein, crude fiber, crude fat, crude ash, dry matter, and moisture content (Mæhre, 2018). It is done using various tests using different apparatuses for each substance measured and is a standardized test for chicken and pig feeds. This was used to determine the calcium content of the crab shells.

Following the statements above, this study aims to investigate the effect of using crab exoskeletons as a dietary calcium source on the egg quality of layer hens in terms of egg characteristics, specifically, egg weight, egg yolk weight, albumen weight, shell thickness, and egg yolk color.

## 2. METHODOLOGY

### 2.1 Site and duration of the study

The study was conducted from January 2020 to February 2020 at the University Animal Farm, Institute of Animal Science, College of Agriculture and Food Science, University of the Philippines Los Baños, Laguna.

### 2.2 Experimental design

A total of two-hundred forty (240) laying hens, provided by the UPLB-IAS, were housed and fed at the University Animal Farm and were at post-peak of production (H&N Super Nick).

The hens were randomly allotted to three different dietary treatments of ten replicates, each with eight chickens. The total number of laid eggs was recorded daily. Egg characteristics were recorded during the last week of feeding.

### 2.3 Feed formulation and feeding

Three different experimental layer diets had been formulated in crumble form. The first diet was the control diet with a formulation given by UPLB-IAS. The second diet was the same formulation as the first diet added with one kilogram per ton of capsorubin and one kilogram per ton of lutein, both provided by UPLB-IAS. The third diet was also the same formulation as the first diet added with 1% crab shell meal. The base feed was milled with respective components using a mill. Each pen was offered with

their diet and water ad libitum for four weeks. The diet composition used for feeding the hens is shown in Table 2.1.

**Table 2.1** Composition of Experimental Diets of Layer Hens

Ingredient	Amount (%)		
	Negative Control Diet	Positive Control Diet	Experimental Diet
Corn	46.22	46.22	46.22
Soya	29.52	29.52	29.52
Limestone	9.46	9.46	9.46
RBD 1	7.78	7.78	7.78
Coco oil	2.65	2.65	2.65
Molasses	2	2	2
MDCP	1.53	1.53	1.53
Iodized Salt	0.25	0.25	0.25
Vitamins	0.12	0.12	0.12
DL-meth	0.12	0.12	0.12
Choline Powder	0.1	0.1	0.1
Minerals	0.1	0.1	0.1
Toxin binder	0.05	0.05	0.05
Mold inhibitor	0.05	0.05	0.05
Antioxidant	0.05	0.05	0.05
Crab meal	0	0	1
Capsorubin (per ton)	0	0.1	0
Lutein (per ton)	0	0.1	0

### 2.4 Proximate analysis

The crab exoskeleton had undergone proximate analysis at LQCC. Proximate analysis was done to determine the components of the exoskeleton of the crab. The guidelines given by LQCC were followed for the preparation of crab shell meals for analysis. The components of the base diet are gathered through the indicated values in the sack of the feed.

### 2.5 Data collection

Eggs were collected for analysis at the end of the 28-day experimental period with 139 eggs. Individual eggs were weighed using a standard digital weighing scale. The eggs were broken manually, and the egg yolk was separated from the egg white using a manual egg separator. The color of the egg yolks was measured in two different methods. The first method used a DSM Yolk fan and was performed by one researcher only. The second method used a Konica Minolta Chroma Meter CR-410, provided by UPLB-IAS Director. The Chroma meter was calibrated first before the start of collection using the proper procedure instructed by the manufacturer. The shell thickness was measured using a digital caliper and was measured in three different parts of an egg, the tip, middle, and butt. Shell weight was recorded after eight (8) days of drying at room temperature.





### 2.5 Statistical Treatment

The data collected from the eggs were analyzed statistically using the Kruskal-Wallis test at 95% confidence interval through SPSS statistical software to observe the differences between the values of the variables, which are the egg qualities, among the three groups. The researchers originally planned to use One-way ANOVA by comparing the mean of the variables from each treatment since this is the most suitable statistical analysis for the data because this can determine if there is a significant difference in the effect of the independent variables (treatments) to the dependent variables (egg qualities). However, the data violated multiple assumptions of tests, including the normality using Kolmogorov-Smirnov test and homogeneity of variance using Levene's test returning results unsuitable for One-way ANOVA. The data also underwent screening using box plotting to determine extreme outliers. The groups were compared to each other to determine if there is a significant difference among the groups. They were further compared by pair to decide which groups contained substantial differences.

**Table 3.1** Summary of Means and Kruskal Wallis Analysis of the egg characteristics at 95% confidence interval ( $\alpha = 0.05$ ).

Treatment	Weight (g)				Shell thickness (mm)	Chroma meter			(DSM yolk Fan)
	Egg	Egg White	Yolk	(Shell)		(L*)	(a*)	(b*)	
Negative	63.65±0.82	36.41±0.67	17.61±0.26	5.84±0.9b	82.66±0.320±0.01a	b	10.18±0.21b	56.46±0.81b	5.91±0.14c
Experimental	63.37±0.91	35.71±0.70	17.60±0.29	5.95±0.1a	82.35±0.316±0.01	a	10.92±0.30a	56.00±0.61a	6.51±0.20ab
Positive	62.10±0.77	34.97±0.57	17.33±0.23	5.57±0.9ab	74.61±0.296±0.01a	ab	23.75±0.28ab	51.33±0.64ab	11.95±0.12bc

Results were presented as mean ± S.E. of 10 replicates observation. groups with significant difference ( $p < 0.05$ ) have parenthesis in their row heading. L\* is a measurement of black to white on a scale of 0 to 100. a\* is a measurement of green (-) to red (+). b\* is a measurement of blue (-) to yellow (+). Values with the same letter (a,b) in the same column are significantly different from each other.

## 3. RESULTS

### 3.1 Weight

In Table 4.1, the negative control group (NCG) exhibits the highest values in egg yolk, egg white, and the whole egg weight among the other groups.

The experimental group (EG) has the highest value in shell weight, which is significantly higher than the positive control group (PCG) but not with the NCG. The difference between the three groups is significantly different.

### 3.2 Shell Thickness

In Table 4.1, the negative control group exhibits the highest eggshell thickness value compared to the other group. It is only significantly higher in the positive control group and not in the experimental group.

### 3.3 Yolk color

In terms of Chroma meter measure measurement, PCG has the highest a\* value which means it is the reddest in color among the feeds. Still, it also has the lowest value in L\* and b\*, which indicates that it has a darker color and the least yellow. It also exhibited the highest yolk color rating in terms of the DSM yolk Fan, with a mean of 11.95

In comparing NCG and EG, NCG has a greater L\* value which means it is more light-colored than EG; however, its a\* value is less than the experimental, which indicates that the experimental is redder in color. The highest b\* value is shown by the negative control group, which means it is the most yellow.

## 4. DISCUSSION

From the results, it can be said that there is no significant difference ( $\alpha = 0.05$ ) in the effect of *C. sapidus*-based feeds on egg weight when compared among the groups.

NCG has the heaviest albumen weight values, whereas EG may have lighter weight but has values that can be attributed to calcium content. This was supported by data in the study of Ribeiro et al. (2016), where they also observed that increasing the amount of calcium in the diet decreases the amount of albumen in the egg.

In terms of shell weight, the EG has the highest value. It supports the proximate analysis of experimental feed and crab meal that it has higher calcium content than the other group. This was in line with the study of Ribeiro, et al. (2016) since their research observed that an increase in calcium content also increases the shell weight. There is a significant difference ( $\alpha = 0.05$ ) in *C. sapidus*-based feeds on shell weight compared to the groups.

The NCG has the highest shell thickness value, but its feed calcium content does not contain the highest calcium. There is a significant difference ( $\alpha = 0.05$ ) in the effect of *C. sapidus*-based feeds on shell thickness when compared to the PCG but has no significant difference when compared to the NCG. There may be other factors that affect the eggshell thickness, including the physical characteristics of the layer hen.

For the yolk color based on the Chroma meter, the NCG and the EG have values that are not



significantly different, but the PCG has a significantly different value than the two groups. There is a significant difference ( $\alpha=0.05$ ) in the effect of *C. sapidus*-based feeds on yolk color  $L^*$ ,  $a^*$ , and  $b^*$  when compared among the groups. There is a significant difference in *C. sapidus*-based feeds on yolk color  $L^*$ ,  $a^*$ , and  $b^*$  when compared to the PCG but has no significant difference compared to the NCG.

There is a significant difference ( $\alpha=0.05$ ) in *C. sapidus*-based feeds on DSM fan yolk color compared to the groups. The PCG also exhibited the highest yolk color rating in terms of the DSM yolk Fan, with a mean of 11.96 among the varied group. Since the PCG is the basal feed diet supplemented with capsorubin and lutein as egg yolk colorants, the egg yolk color would appear to become much brighter among the three groups. This is supported by Grashorn (2016) study, where it was found that the addition of red and yellow colorants in the egg affects the color of the yolk, which makes it more golden-orange.

## 5. CONCLUSION

In the study, three groups of layer hens were subjected to three different treatments, NCG, PCG, and EG.

The EG had the eggshells with the most positive significant weight difference but did not significantly change the egg yolk color compared to the NCG. The PCG had the most different egg yolk color yield among the treatments. It could be said from here that ground crab exoskeleton may be a viable calcium supplement for layer hen feeds but may not be a viable egg yolk colorant.

The proximate analysis results further support the effectiveness of the crab exoskeletons as a calcium supplement due to the calcium composition of the crab meal being higher than that of the basal feed diet at 23.59%.

However, compared to limestone grits, the most commonly used calcium supplement, ground crab exoskeleton, has a considerably lower calcium content. Thus, it could be said that limestone grits may still be more effective as a calcium supplement on a basal feed diet. With these mentioned, it can be concluded that ground crab exoskeletons have the potential to be used as a commercially available calcium supplement for layer hens but not as a viable source of egg yolk colorant. However, it may work in conjunction with the egg colorants used in the PCG, namely capsorubin and lutein, as supplements for calcium and egg yolk colorants.

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## COVID-19 Swab Test Experiences of Employees as Required By Their Employers

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**Abstract:** Undergoing swab tests to ensure a safe work environment was required by the national government due to the COVID-19 pandemic. The Department of Labor and Employment (DOLE, 2020) stated the need for regular swab testing of workers in various sectors to prevent the further spread of the virus. Data was gathered from the employees of the Bridgestone Company in Rosario, Cavite. The study aims to know the experiences of the Bridgestone employees who underwent the COVID-19 swab testing and to know how they viewed it in the context of workforce productivity. The researchers used a phenomenological approach and utilized interview guides for the data collection. Seventeen questions were asked during the course of collecting data, and participants were selected based on quota sampling. The findings showed that the process of undergoing the COVID-19 swab test was painful, yet the procedure was done quickly. Conclusions of the findings showed that undergoing the swab test was painful, but it was essential and contributed to the productivity of the employees of the Bridgestone Company.

**Key Words:** swab testing; COVID-19; experiences; productivity; pandemic

### 1. INTRODUCTION

Despite the COVID-19 pandemic, work continues and thus is affected by the implementation of travel bans, skeleton crews, remote work, and social distancing. In many organizations, these changes have raised questions and concerns (Anthony & Patrick, 2020). With the implementation of such protocols, the Philippine government required swab testing for employees to ensure a safe working environment. The COVID-19 swab test involves a six-inch-long nasopharyngeal swab cavity inserted between the nose and mouth (UC Davis Health, 2020). This process must be done regularly to prevent the further transmission of the disease within offices and factories (Department of Labor and Employment [DOLE], 2020).

As COVID-19 spread in two hundred sixteen countries, the disease was considered a health crisis pandemic by the World Health Organization (WHO, 2020). There has been an excess of eighty thousand reported cases as of 2020 in the Philippines, as reported by the Department of Health (DOH). Cases continue to rise, and it exerts implications on the jobs of citizens. As swab testing was implemented, DOH Undersecretary Marie Rosario Vergerie claims that the laboratories of the Philippine Red Cross are capable of conducting five thousand tests a day (Gonzales, 2020).

Williams and Haire (2020) stated that the operation of swab testing may cause fears, such as

fearing the swab test procedure, suspicions on government and healthcare programs, and possible results from the extent of public health inspections. Hence, the fear of COVID-19 and its implications must be addressed since it may lead to enhanced job outcomes, increased job satisfaction, decreased levels of stress, and reduced intention to resign from their profession (Labargue & Delos Santos, 2020).

Furthermore, the researchers wanted to know the experiences of the Bridgestone employees who underwent the COVID-19 swab-testing and how they viewed the swab test procedure in the context of productivity within the workforce during the pandemic.

### 2. METHODOLOGY

#### *Research Design*

The researchers conducted the study using the phenomenological approach. As defined by Sokolowski (2000), phenomenology is the study of peoples' experiences and how they present themselves to others. The phenomenological design attempts to understand the meaning and significance of a particular phenomenon (Manen, 1990).

#### *Method of Collecting Data and Development of Research Instrument*

The researchers used an interview guide to collect data. It consisted of seventeen questions



regarding the participants' subjective and necessary personal data. Interview guides were used during the interviews to help the researchers focus on the topic. Moreover, conducting interviews was appropriate for this study since it explores various views, experiences, beliefs, and motivations (Gill et al., 2008). They helped the researchers understand the attitudes, actions, perceptions, and experiences of the participants toward the matter being studied.

### *Sampling Design*

The researchers used quota sampling for the selection of participants. According to Saunders, Lewis, and Thornhill (2012), quota sampling is a method of non-probability sampling and can be described as a sampling method for collecting representative data from a population. Its implementation ensures that a sample group represents certain features of the population selected by the researchers. For practical purposes, Crouch and McKenzie (2006) recommend that fewer than twenty participants in a qualitative study assist a researcher to develop and sustain a close relationship, thus enhancing the "open" and "frank" exchange of knowledge. Moreover, Creswell (1998) proposes five to twenty-five participants for phenomenological studies, and Morse (1994) suggests at least six. These guidelines help a researcher predict how many participants they need. However, the necessary number of participants should still depend on when saturation is achieved.

Ten employees were gathered by the researchers. The area of the study was restricted to Bridgestone Precision Molding Philippines, Inc. in Rosario, Cavite. An unstructured interview for the study was administered to all ten participants. The selection of the participants was conducted from the population of Bridgestone employees that were required to undergo the COVID-19 swab test and whose availability and attitude was compatible with the study. The size and length of the interview guide were kept optimum.

## 3. RESULTS AND DISCUSSION

### *3.1 What are the experiences of the Bridgestone employees who underwent the COVID-19 swab testing?*

Nervousness was a typical reaction for those who experienced swab testing for fear of the COVID-19 pandemic. The participants felt nervous about the results as they thought that their results were positive. They feared that they might infect their family and loved ones. Some employees were sad due to the possible discrimination a test result might give them. The data of the participants were collected for

tracing and to check their background. This procedure was done by the authority who executed the swab test, ensuring a proper diagnosis.

The nose and throat swab test can miss around thirty percent to fifty percent of infections, according to the University of Cambridge team (as cited in Boseley, 2020), since the virus can disappear from the upper lung unto the lungs. But it can be solved by adding antibody tests that provide sufficient data. Some swabs might not show a hundred percent accuracy. A false-positive result may lead to unnecessary treatment for the uninfected individual. It can also lead to societal dilemmas for people who are essential in public services, such as health and social care operators, police officers, firefighters, and the like. A false-negative result given to a positive patient for COVID-19 may potentially contribute to the spread of the virus by human-to-human transmission.

Participants said that the whole swab testing procedure occurred between one to ten minutes. Physical pain was felt by the participants after the process of swab testing. Additionally, they still needed to wait three days for the result.

### *3.2 What meanings do the Bridgestone employees give from their experience of swab testing?*

Some participants said that swab tests were important for them to be aware if they were affected by the virus or not. The Center for Disease Control (CDC) recommended that critical infrastructure employees may be allowed to continue working after possible exposure to COVID-19, to ensure the continuity of operations of vital functions. It would be more beneficial if everyone would undergo swab testing. This can help provide more explicit pictures for contact tracing and help them assess what they can do to eliminate the virus.

Swab testing can be the employee's protection barrier against the infection of COVID-19. One employee said that the company could not just eliminate people in the workforce (as it might affect the company's production). Most of the participants said that after undergoing the swab test, they became health-conscious.

The participants said they became more well-informed of their surroundings after taking the swab test, considering that they were initially anxious and fearful of the potential consequences of COVID-19. Becoming more conscious can be related to the Protection Motivation Theory's response efficacy.



### *3.3 How do employees view swab tests in relation to the productivity of the workforce during a pandemic?*

Some of the participants said that as part of the swab test process, they were asked to quarantine. Aligned with this, they could not report to work. For companies and employers to prepare for and respond to COVID-19, the CDC developed interim guidelines. The interim guidelines are structured to reduce exposure to acute respiratory diseases, including COVID-19, in the workplace. As group transmission of COVID-19 progresses, the guidelines also discuss concerns that can assist employers. The guidelines are intended for non-healthcare environments; guidelines unique to them should be consulted by healthcare staff and employers. Using appropriate combinations of engineering and administrative controls, safe work practices, and personal protective equipment (PPE) to avoid worker exposure, employers should adjust infection prevention techniques based on a comprehensive hazard assessment (Occupational Safety and Health Administration, 2020).

Some participants also said that the swab test made their production slow as they were scared to interact with each other. A study written by Joel Carnevale and Isabelle Hatak entitled "Employee Adjustment and Well-Being in the Era of COVID-19: Implications for Human Resource Management" claims that COVID-19 is the accelerator for one of the most drastic changes to workplace transformations. Theories that highlight employee-environment theory would be necessary because motivation would be affected by the change in values. The increase in job autonomy may cause family-related problems that may surface within work-from-home situations, so there is a need for providing employees with the right resources to manage conflicting work and family demands. Organizations must also enhance relationship-oriented human resource systems to combat the risk of isolation among independent employees and prepare them for situations like the current crisis (Donthu & Gustafsson, 2020).

The participants said that the swab test helped to bring back the company's full productivity workforce amidst the pandemic. There would be a period after the pandemic when people would tend to focus more on saving capital rather than investing, resulting in reduced economic growth. With the situation, saving capital means negative returns; it is not certain that we would be as conservative as we were in the past. Retailers and brands face challenges related to health and safety, supply chain, the workforce, cash flow, consumer demand, sales, and marketing. But once humanity is through this pandemic, people would have a different world than the world before the pandemic. Companies would

implement an indefinite hiring freeze while online communication, entertainment, and shopping would grow and expand (Donthu & Gustafsson, 2020).

## 4. CONCLUSIONS

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

4.1 The researchers conclude that the conducted COVID-19 swab test returned the company's productivity workforce to one-hundred percent. When the COVID-19 pandemic started, only fifty percent of employees were allowed to work in the company. After conducting the swab test, the company's productivity workforce was able to return to a hundred percent, considering that it helped limit the spread of the virus and diminished the COVID-19 cases in Bridgestone company.

4.2 The researchers conclude that the COVID-19 swab test caused fear and assurance to the Bridgestone Company employees. Before the employees had the swab test, they feared the possibility of becoming positive for COVID-19 and the idea that the swab test process is painful. Afterward, the COVID-19 swab test results provided assurance of whether they were infected or not. They have also become more well-informed about their surroundings and become health conscious after taking the swab test.

4.3 The researchers conclude that the procedure of the COVID-19 swab test was excruciating. After the Bridgestone Company employees took the swab test, they mentioned that they felt physical pain due to the insertion of a six-inch-long swab into the cavity between their nose and mouth.

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## A Comparative Analysis on the Mechanical Properties of Abaca, Banana, and Coir Fiber Reinforced Polymer Rebars

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**Abstract:** The researchers conducted a comparative analysis between abaca, banana, and coir FRP rebars to introduce more local and ecological composite materials to the construction industry. This research aims to analyze the mechanical properties of abaca, banana, and coir FRP composites and determine the appropriate chemical treatment and fiber content to yield the most optimum values for each. The values of each composite were compared to each other through bar graphs. The data collected from previous studies were limited to the mechanical properties of tensile, flexural, and impact strength and chemical treatment and fiber content parameters. The type of chemical treatment and the amount of fiber was different among the three NFRP composites. Moreover, abaca had the highest flexural strength, the banana had the highest tensile strength, and coir had the highest impact strength.

**Key Words:** FRP composite; natural fiber; rebars; mechanical properties; NFRP

### 1. INTRODUCTION

Rebars are reinforced in concrete structures to increase concrete's tensile strength due to its tension weakness (What is Rebar? Types and Grades of Steel Reinforcement, 2018). Deformed steel rebars are frequently used; however, these types of rebars are corrosive and expensive. Researchers have proposed fiber-reinforced polymer (FRP) rebar as an alternative. They are characterized as lightweight and high strength-to-weight ratio (El-Hassan & El Maaddawy, 2019). FRP rebars are composite materials made of polymer matrix with reinforced fibers (Belarbi & Acun, 2013). Fibers of FRP's are usually synthetic (Begum & Islam, 2013). However, synthetic FRP composites have serious disadvantages: high cost, high density, non-renewable, and high energy consumption. Synthetic FRP composite production results in increased carbon emissions (Sanal & Verma, 2018). The architecture, engineering, and construction industry consume approximately 23% of national energy and produces 40% of carbon emission (Seungho & Seunguk, 2017).

The research problem covers Sustainable Development Goals, 12 & 13, and 9 & 11. Natural FRP (NFRP) rebar is recognized as an ecological alternative to synthetic FRP rebar. Their advantages include low cost, low density, sustainability, and minor damage to processing equipment (Punyamurthy, Sampathkumar, Ranganagowda, et al., 2014). In this study, NFRP rebars, specifically abaca, banana, and coir FRP, were compared. Abaca, banana, and coir fibers are leaf fibers (Mohammed et al., 2015) available in the Philippines. They are used in producing FRP rebars due to their immense mechanical strength, resistance to saltwater damage

and decaying, long fiber length, high tensile and flexural strength (Punyamurthy, Sampathkumar, Bennehalli, & Badyankal, 2014).

This research aims to analyze and compare the mechanical properties (tensile, flexural, and impact strength) of abaca, coir, and banana FRP composites, investigate their mechanical properties when chemically treated, and determine the appropriate fiber content for each. This study may benefit civil and structural engineers, students, and future researchers in finding more local and affordable resources in reinforced concrete and masonry structures.

### 2. METHODOLOGY

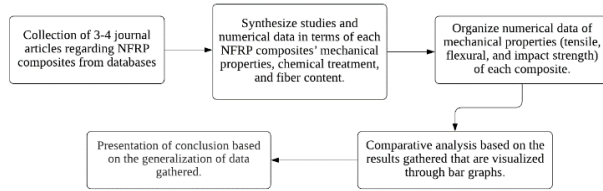
#### 2.1 Nature of Data

The study used secondary sources published from 2010-2020. Sources were collected from databases of Google Scholar, Science Direct, and EBSCO hosts. The numerical data of the mechanical properties were arranged into tables and graphs in Microsoft Excel.

#### 2.2 Identifying Research Objectives

Peer-reviewed journals were used to provide general information about NFRP composites. The study focused on three natural fibers: abaca, banana, and coir fibers. Studies have shown that each kind of NFRP composite requires a certain amount of fiber content and a specific type of chemical treatment to achieve optimum mechanical properties. This led to the formulation of the main research objectives for the study.

### 2.3 Data Collection



**Figure 2.2** General Procedure of the Study

Above is the general procedure of the study. Three to four journal articles per composite were chosen based on their abstract. Selected articles provided the effect of fiber content and chemical treatment on mechanical properties. Parameters such as fiber length and type of matrix were excluded. Upon synthesis of the studies, numerical data of each NFRP composites' mechanical properties were collected. The data collection was patterned after a literature review of natural FRP composites by Mahir et al. (2019).

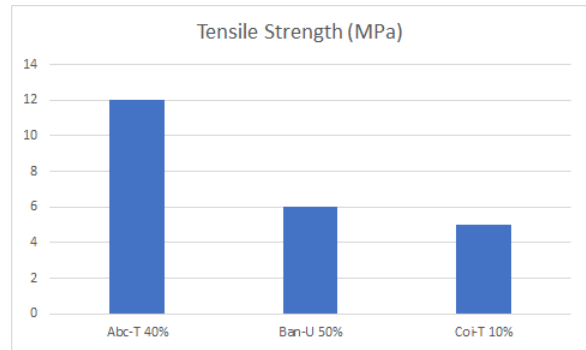
### 2.4 Data Organization and Analysis

The researchers arranged numerical data of mechanical properties: tensile, flexural, and impact strength into tables. Abaca, banana, and coir FRP composites had separate tables showing their mechanical properties, corresponding fiber content, and chemical treatment. Mahir et al. (2019) arranged each resin type into tables that show its corresponding fiber type and content and chemical treatment.

**Table 2.1** Sample table

Fiber content (wt. %)	Chemical treatment	Tensile strength (MPa)	Flexural strength (MPa)	Impact strength (mJ/mm <sup>2</sup> )	Authors
40	Benzene diazonium chloride	-	-	7.68	(Punyamurthy, R. et al, 2014)

Each mechanical property had a bar graph that compared the most optimum mechanical properties of each composite. Another review about natural FRP composites conducted by Vigneshwaran et al. (2020) used bar graphs to compare tensile, flexural, and impact strength among different polypropylene types of natural fiber composites.



**Figure 2.2** Sample Bar Graph

## 3. RESULTS AND DISCUSSION

### 3.1 Chemical Treatment and Fiber Content

Chemical treatment aids in the polymer-fiber adhesion by improving compatibility between the hydrophilic fiber and hydrophobic polymer. SEM micrographs analyzed by Rahman et al. (2009) show that untreated abaca fibers display multiple fiber pullouts, micro-voids, and fiber agglomeration resulting in poor fiber-matrix adhesion while treated fibers display better fiber-matrix adhesion. SEM micrographs show that chemical treatment removes hemicellulose and lignin in the fiber, resulting in increased surface roughness (Punyamurthy, Sampathkumar, Bennehalli, Patel, et al., 2014). In table 3.1, benzene diazonium chloride ((C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>)Cl) treatment is mainly included in abaca FRP composites since this treatment exhibit a significant increase in tensile, flexural, and impact strength (Punyamurthy, Sampathkumar, Bennehalli, & Badyankal, 2014). (C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>)Cl treatment lessens the hydrophilic nature of fibers to increase fiber-polymer compatibility through the coupling reaction with the -OH group, producing diazo cellulose compound.

Mechanical properties of abaca FRP composites increased towards the fiber content of 40% then gradually decreased when the fiber content is more than 40% (Punyamurthy, Sampathkumar, Bennehalli, Patel, et al., 2014). As observed in the SEM micrograph analyzed by Punyamurthy, Sampathkumar, Ranganagowda, et al. (2014), the composite with more than 40% fiber content has excess fiber not homogenized with the polymer, while the composite with less than 40% fiber content has fiber fractures which caused inefficient stress transfer. This being the case, 40% fiber content is the most appropriate amount.



**Table 3.1 Mechanical Properties of Abaca FRP composite**

Fiber content (wt.%)	Chemical treatment	Tensile strength (MPa)	Flexural strength (MPa)	Impact strength (mJ/mm <sup>2</sup> )	Authors
40	Benzene diazonium chloride	-	-	7.68	(Punyamurthy, Sampathkumar, Bennehalli, Patel, et al., 2014)
40	Benzene diazonium chloride	73.5	81.2	6.81	(Punyamurthy, Sampathkumar, Ranganagowda, et al., 2014)
10	Benzene diazonium salt	31.2	55.1	4.5 x 10 <sup>-3</sup>	(Rahman et al., 2009)
25	Benzene diazonium salt	28.7	56	5.3 x 10 <sup>-3</sup>	(Rahman et al., 2009)
40	Benzene diazonium chloride	73.1	-	-	(Punyamurthy, Sampathkumar, Bennehalli, & Badyankal, 2014)

In table 3.2, alkaline treatment for banana fibers exhibited the most optimum mechanical properties. Alkaline treatment removes hemicellulose and other non-cellulosic substances from the fiber surface thus, improving fiber-matrix adhesion and tensile strength (Komal et al., 2018). SEM micrographs show that alkali-treated banana fibers have clean surfaces and slightly separated fibers (Prasad et al., 2016). The alkaline treatment provides better flexural strength by improving fiber stiffness.

Mechanical properties of untreated fibers decreased when fiber content increased due to weak fiber-polymer compatibility (Prasad et al., 2016). Significant fiber content caused stress transfer inefficiency between the fiber and polymer. This trend is also observed in the tensile strength of treated fibers (Komal et al., 2018). Impact strength decreased as untreated fiber content increased, but improvement in values is seen in the fiber content range of 15%-30%. Although, for the flexural strength of treated fibers, it is observed that values increased as fiber content increased due to improved fiber stiffness. 50% fiber content displayed excellent results to withstand large load amounts (Aswin et al., 2014). In terms of flexural strength and impact strength, 60% fiber content exhibited maximum values.

**Table 3.2 Mechanical Properties of Banana FRP composite**

Fiber content (wt.%)	Chemical treatment	Tensile strength (MPa)	Flexural strength (MPa)	Impact strength (mJ/mm <sup>2</sup> )	Authors
20	-	13.5	22.5	-	(Chester, P., & Jordan, W., 2017)
50	-	112.58	64.68	9.48	(Aswin et al., 2014)
60	-	98.34	77.21	11.2	(Aswin et al., 2014)
25	Alkali treatment	10.9	19.2	11.8	(Prasad, N., Agarwal, V. K., & Sinha, S., 2016)
25	Acrylic acid treatment	10.7	19.9	12.3	(Prasad, N., Agarwal, V. K., & Sinha, S., 2016)
10	Alkaline treatment	28	58	-	(Komal et al., 2018)
20	Alkaline treatment	27	61	-	(Komal et al., 2018)

Coir fiber treated with benzene diazonium treatment exhibit optimum mechanical properties. In table 3, benzene diazonium treatment had the highest tensile strength and flexural strength (Haque et al., 2010). Benzene diazonium treatment caused effective stress transfer between coir fiber and polymer, resulting in improved fiber-polymer matrix adhesion. Sodium bicarbonate treatment does not improve the mechanical properties of fiber since it did not significantly modify the fiber surface for better fiber-polymer compatibility (Santos et al., 2019). However, sodium bicarbonate treatment displayed better impact strength and flexural strength values due to longer treatment time, which caused improvement of fiber stiffness.

The tensile strength of treated composites increased as fiber content decreased. Haque et al. (2010) tested composites with different fiber loadings, 15% being the lowest, and the results showed that 15% got the maximum values of tensile strength. Stress transfer in the composite is more effective in less fiber content. Flexural strength and impact strength of treated composites increased as fiber content increased due to the improved stiffness of the composite. This trend is also the same for untreated fibers. Naveen et al. (2013) observed the tensile strengths of untreated composites at different fiber contents. Maximum values of tensile strength are kept at the lowest fiber content (5%).

**Table 3.3 Mechanical Properties of Coir FRP composite**

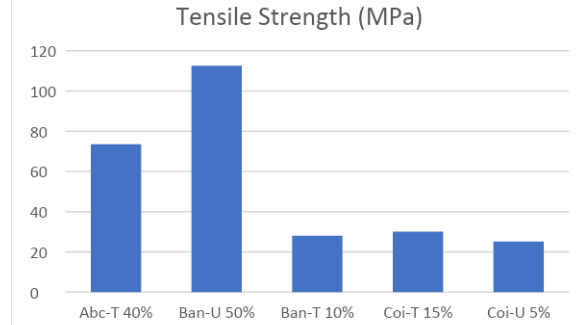
Fiber content (wt.%)	Chemical treatment	Tensile strength (MPa)	Flexural strength (MPa)	Impact strength (mJ/mm <sup>2</sup> )	Authors
15	benzene diazonium salt	30.1	56.2	5.6 x 10 <sup>-5</sup>	(Haque et al., 2010)
30	benzene diazonium salt	26.3	58.5	6.2 x 10 <sup>-5</sup>	(Haque et al., 2010)
-	Sodium bicarbonate treatment	18.77	28.37	18.03	(Santos et al., 2019)
-	Sodium bicarbonate treatment	12.53	40.44	6.38	(Santos et al., 2019)
-	Alkali treatment	23.8	40.4	-	(Yan et al., 2016)
5	-	25.2	-	-	(Naveen et al., 2013)

### 3.2 Tensile Strength

In figure 3.1, coir FRP has the lowest value of tensile strength. Raw coir fibers have low tensile strengths (Yan et al., 2016). This is caused by the chemical composition of coir fiber which contains low cellulose content and large micro-fibrils angle. On the other hand, raw abaca fiber (Punyamurthy, Sampathkumar, Bennehalli, Patel, et al., 2014) and raw banana fiber (Prasad et al., 2016) naturally have high tensile strengths due to their high cellulose content. Untreated banana fiber has the highest value



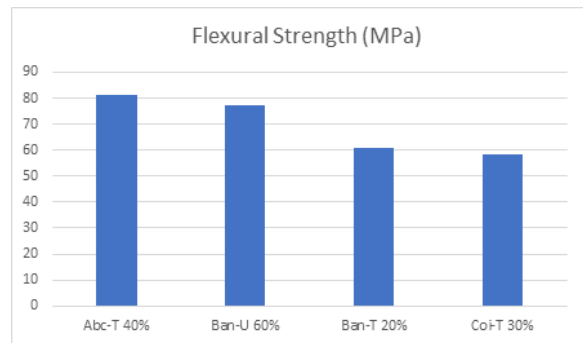
since its fiber content is 50% which is the appropriate fiber content for banana FRP's. Figure 3.1 shows that banana untreated FRP has the highest tensile strength due to fiber's high cellulose content and proper fiber content in the composite.



**Figure 3.1** Tensile Strength of composites

### 3.3 Flexural Strength

Abaca and banana fiber FRP display better flexural strength, as seen in Figure 2. Flexural strength of abaca and banana fibers is nearer to that of glass fibers (Punyamurthy, R., Sampathkumar, D., Bennehalli, B., & Badyankal, P., 2014) (Prasad et al., 2016). Abaca FRP treated with 40% fiber content displayed the highest flexural strength. Banana FRP had the lower value since broken banana fibers are arranged perpendicular to the application of flexural loads, shown in SEM micrographs (Aswin, et al., 2014). Banana untreated displayed better flexural strength than banana treated because the fiber content of the untreated FRP is 60%.

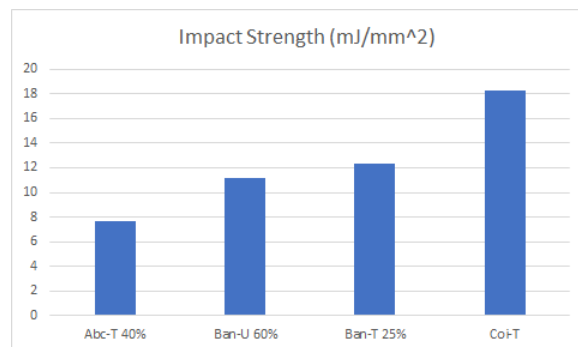


**Figure 3.2** Flexural Strength of composites

### 3.4 Impact Strength

In figure 3, treated coir FRP showed the highest impact strength. SEM micrographs show that low impact strength is associated with better fiber-matrix adhesion and gives rise to fiber fracture, reduced fiber pull-out, and low energy dissipation (Santos et al., 2019). Hence, coir treated FRP is the most optimum because its chemical treatment,

sodium bicarbonate, causes poor fiber-matrix adhesion. Abaca treated FRP displayed the lowest impact strength since its chemical treatment, benzene diazonium, is the most effective treatment for fiber-matrix adhesion, and it causes reduced fiber pull-out (Rahman et al., 2009). More fiber content requires more fiber-pullout force, thus improving impact strength (Haque et al., 2010). For this reason, 60% untreated banana FRP displayed better impact strength compared to 40% treated abaca FRP. Prasad et al. (2016) showed that impact strengths of untreated banana fibers increase from fiber contents of 15%-30%. Thus, 60% treated banana FRP has a slightly lower impact strength value than 25% untreated banana FRP.



**Figure 3.3** Impact Strength of composites

## 4. CONCLUSIONS

Researchers concluded that the type of chemical treatment and fiber content are different among the three NFRP composites from the studies collected. Abaca FRP composite is most optimum at 40% fiber content, benzene diazonium treatment. Banana FRP composite is most optimum at 50% fiber content, alkaline treatment. Coir FRP composite is most optimum at 15% fiber content, benzene diazonium treatment.

Comparing the mechanical properties among the three NFRP, abaca FRP had the highest flexural strength (81.2 MPa), banana FRP had the highest tensile strength (112.58 MPa), and coir FRP had the highest impact strength (18.03 mJ/mm<sup>2</sup>).

The study has the potential to exceed the objectives of the study. Modifying variables, specifically the NFRP composites with other local or hybrid NFRP's, is highly recommended to observe improvements in results. Also, other properties of composites such as thermal properties and energy & moisture absorption may be discussed to examine other factors further. Considering other chemical treatments is also encouraged. Use of more established data collection and analysis methods shall be conducted depending on the objectives. Lastly,



exploring other natural fibers and renewable sources must be done to promote the optimization of such resources.

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## Utilizing Cucurbita moschata Duch. (Winter Squash) Fruit Peels as a Viable Component of Paper

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**Abstract:** Cucurbita moschata Duch., more commonly known as winter squash, is economically and globally important. However, given that one-third of the food made for human consumption is wasted and never consumed, this fruit is not being utilized to its full potential. As the main component of fruit-based papers such as bananas, coconuts, and corn, winter squash is rich in soluble and insoluble fiber. To resolve the 12th United Nations Sustainable Development Goal: Responsible Consumption and Production, the effectiveness, durability, tensile strength, and biodegradability of winter squash peels as the main component of homemade paper production were investigated. The produced paper underwent 20 trials of tensile strength test, scratch test, and soil burial test using an experimental research design. It was only able to pass the tensile strength test. In contrast, it failed in terms of durability and biodegradability, possibly due to the limited testing procedures and allotted time for testing. Therefore, the utilization of winter squash in paper production was ineffective in terms of the criteria mentioned above and needs further research to be classified as a practical alternative paper component.

**Key Words:** Cucurbita moschata Duch.; paper; tensile strength; durability; biodegradability

### 1. INTRODUCTION

#### 1.1 Background of the Study

Ever since the invention of paper, it has been used for various purposes throughout history. Paper has developed into different forms. For instance, according to Aithal (2016), it began as clay tablets for record-keeping in Mesopotamia, which evolved to papyrus—a smooth, flexible aquatic plant that can sustain ink—found in the Nile River, Egypt. The Chinese also had their alternative for papyrus, namely bamboo books, which were just as convenient. Since paper is a multipurpose material, it is commonly and frequently used by almost everyone. The World Counts (2020) states that two to three kilograms of trees are needed for one kilogram of paper. Therefore, the increase in paper production subsequently causes an increase in deforestation. As an alternative to using trees, different waste products can be used to manufacture paper that can alleviate the effects of 1.3 billion tons of food waste and 60% yearly fruit and vegetable waste, as David et al. (2019) stated. Furthermore, the Philippines is the 16th producer of winter squash globally and can produce over 247,759 metric tons each year (Tepper, 2013).

#### 1.2 Statement of the Problem

How can squash peels be utilized to create an effective alternative for paper?

- What is the tensile strength of the homemade paper made from squash peels?
- What is the durability or stability of the homemade paper made from squash peels?
- What is the biodegradability and decomposition of squash peel paper?

#### 1.3 Hypothesis

H01: Squash peels are not effective ingredients of durable paper.

Ha1: Squash peels are effective ingredients of durable paper.

H02: The homemade paper will have a tensile strength of less than 3.6 Pa.

Ha2: The homemade paper will have a tensile strength of 3.6 Pa or more.

H03: The homemade paper will be able to endure less than forty-six (46) trials of being written.

Ha3: The homemade paper will be able to endure forty-six (46) or more trials of being written.

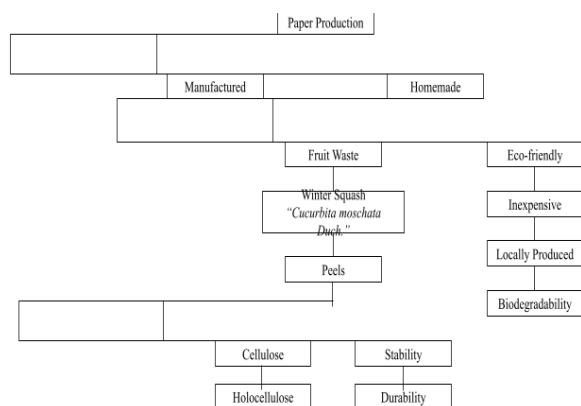
H04: The homemade paper will not show signs of decomposition after ten days buried in the soil.

Ha4: The homemade paper will show decomposition ten days after it is buried in the soil.





### 1. 4 Conceptual Framework



**Figure 1.1** Conceptual Framework for the Paper Production

As shown in Figure 1.1, this research focuses on observing the paper production process in finding a suitable alternative to the ones sold on the market. The researchers decided to show the two main processes available, namely manufactured and homemade. With the homemade process being the focal point, fruit waste from winter squash, scientifically called *Cucurbita moschata Duch.*, was used to create the alternative paper. The fruit peels of the winter squash were chosen as the paper’s main component as it is biodegradable and locally produced, inexpensive, and accessible. Furthermore, winter squash peels contain cellulose and holocellulose, which are rich in fiber.

### 1. 5 Significance of the Study

The independent variable, winter squash fruit peels, was referred to as the essential fruit component the researchers utilized to create homemade paper. The dependent variable, viable and stable paper, was referred to as the goal end product of the whole procedure. Intervening variables, such as the paper production process, were controlled following previous studies to ensure the reliability of the research.

### 1. 6 Scope and Limitations

The study focused on the *Cucurbita moschata Duch.* (winter squash) that is locally available in the Philippines. To provide solutions to the Sustainable Development Goal number 12, Responsible Consumption and Production, as stated by the United Nations (2015), the researchers limited the scope to the winter squash peels. In highlighting the utilization of winter squash peels to create a paper alternative, the main argument that food waste has different and better purposes was shown.

## 2. METHODOLOGY

### 2. 1 Prototype Construction

The research utilized the following items: measuring cups, winter squash, assorted shredded recycled paper, blender, paper mold (silkscreen), and a large basin.

The first step was to blend two grams of winter squash and ½ cup of water for one-two minutes or until the winter squash was completely dissolved. Second, the mixture was poured into a bowl. Next, one cup of paper and one cup of water were blended until the form dissolved. Then, another cup of paper and ½ cup of water was incorporated until the paper broke down. After that, the winter squash mix was added and blended with everything for one to two minutes. The final mixture was poured into a large basin and, using a silkscreen, submerged into the mix. Last, it was taken out to dry.

## 3. DATA ANALYSIS

### 3.1 The Tensile Strength of Squash Peel Paper

**Table 3.A** Amount of Weight the Paper Can Withstand Without Breaking Apart

Trial Paper	Distance of the Paper (inches)	Number of Folds	Amount of Weight it can Handle (g)	Tensile Strength
1	6.5	2	64	10.81 Pa
2	6.5	3	13	2.07 Pa
3	6.5	2	26	4.14 Pa
4	6.5	2	20	3.18 Pa
5	6.5	0	32	5.09 Pa
				Mean: 5.06 Pa

The tensile strength of paper is the maximum amount of force it can withstand without tearing apart. To test the tensile strength of the paper, the assigned researcher placed the paper on top of two identical containers with a constant 6.5-inch distance in between. Through repeated experimentation, the researchers were able to gather the data shown in Table 3.A. Since the experiment was done only at home, the researchers cannot guarantee the accuracy of the data.



**Figure 3.1** *The Testing of Tensile Strength*

The tensile strength of the paper was measured as the force divided by its area. The area of the paper is a constant of 8.5 inches by 11 inches, which in SI units is 0.26 meters by 0.28 meters since that was the size of the silkscreen where the paper was made. The force was measured by multiplying the mass it can handle by the acceleration due to gravity. Below were the computations.

$$s_1 = \frac{(64 \text{ g})(9.8 \frac{\text{m}}{\text{s}^2})}{(0.22 \text{ m})(0.28 \text{ m})} \quad s_2 = \frac{(13 \text{ g})(9.8 \frac{\text{m}}{\text{s}^2})}{(0.22 \text{ m})(0.28 \text{ m})} \quad s_3 = \frac{(26 \text{ g})(9.8 \frac{\text{m}}{\text{s}^2})}{(0.22 \text{ m})(0.28 \text{ m})}$$

$$s_1 = 10 \ 181 \text{ mPa} \quad s_2 = 2 \ 068 \text{ mPa} \quad s_3 = 4 \ 136 \text{ mPa}$$

$$s_1 = 10.18 \text{ Pa} \quad s_2 = 2.07 \text{ Pa} \quad s_3 = 4.14 \text{ Pa}$$

$$s_4 = \frac{(20 \text{ g})(9.8 \frac{\text{m}}{\text{s}^2})}{(0.22 \text{ m})(0.28 \text{ m})} \quad s_5 = \frac{(32 \text{ g})(9.8 \frac{\text{m}}{\text{s}^2})}{(0.22 \text{ m})(0.28 \text{ m})}$$

$$s_4 = 3 \ 181 \text{ mPa} \quad s_5 = 5 \ 090 \text{ mPa}$$

$$s_4 = 3.18 \text{ Pa} \quad s_5 = 5.09 \text{ Pa}$$

### 3. 2 The Durability of Squash Peel Paper

**Table 3.B** *The Number of Trials the Paper Withstood*

Trial Paper	Number of Trials being Written	Number of Times before it Tore
1	3	2
2	8	8
3	11	10
4	9	8
5	9	8
		Mean: 7.2

The durability of the paper is the ability to withstand pressure or damage. Using a pencil and eraser to create multiple erasures on each paper, the researchers found out how durable the papers were with how many times each paper could endure being erased in the same spot numerous times. After a repeated number of trials, the researchers gathered data written in Table 3.b from the experiment. Due to the limited number of papers used, the accuracy of the data collected is not guaranteed.



**Figure 3.2** *The Scratch Test of the Paper*

### 3. 3 The Biodegradability of Squash Peel Paper

**Table 3.C** *Comparison of Paper Mass After Soil Burial*

Trial Paper	Mass Before (g)	Mass After 10 Days (g)
1	0.0045	0.0043
2	0.0036	0.0032
3	0.0051	0.0050
4	0.0073	0.0071
5	0.0039	0.0039
TOTAL: 5	Mean: 0.00488	Mean: 0.0047

According to Goswami & O'Haire (2016), biodegradability is the ability of a substance to degrade after interaction with biological substances. In this experiment, the researchers weighed the squash peel paper before and after being buried in the soil for over ten days. Due to the short amount of time



it was buried, the researchers did not see any substantial difference in the weight of the paper to conclude any biodegradation.

### *3. 4 Squash Peels as an Effective Component of Paper*

Winter squash or *Cucurbita moschata* Duch. was used in the experiment to assess the effectiveness of the peels as a substitute ingredient for paper.

The pulp had a thick consistency and, mixed with the recycled paper, made a very effective pulp mixture. After the pulp was left to dry with the silkscreen in the sun, it became very sturdy and rigid. The results above showed that the prototype paper could not endure the amount of force. The paper did not pass the durability test. Also, evidence from a ten-day biodegradability test showed no change and insufficient evidence. Thus, the prototype passed the tensile strength test but did not pass the durability or biodegradability tests.

## 4. CONCLUSIONS

### *4.1. Conclusions*

After conducting different testing procedures, particularly regarding the paper's effectiveness, tensile strength, durability, and biodegradability, the initial hypothesis of the research is not entirely accurate. The mixture obtained from the chosen ingredients was thick enough to be molded into the paper. However, it was not a practical alternative based on all three standards. With the testing of the paper's approximate ability to handle a certain amount of force and withstand tear, the paper was able to pass the test for tensile strength. Nevertheless, the paper's inability to resist progressive damages determined its durability to be below expected standards. Lack of adequate time was the main reason the research's biodegradability test had no substantial result. Therefore, the data gathered may not be reliable.

### *4.2 Summary*

Through rigorous research and investigation of the initial research inquiries, the hypothesis that *Cucurbita moschata* Duch. (winter squash) fruit peels could be utilized as a viable component of paper was found to be inaccurate and false. In gathering data through the different testing procedures, the produced paper's tensile strength, durability, and biodegradability were not adequate to be used similarly to standard paper. Thus, this proved the whole research process to be unsuccessful.

### *4.3 Limitations*

Due to the pandemic, the research was limited to being conducted within the homes of each researcher. Since the testing procedures were done in different research environments, the data from each experiment may not be as reliable as having the same research environment throughout. Moreover, the lack of proper laboratory equipment and measuring devices hindered the researchers from obtaining more accurate data. Therefore, the researchers had to utilize simple testing procedures to be quickly done within their homes.

### *4.4 Recommendations*

It is recommended that the testing procedures be done within the same environment to rule out miscellaneous variables that may affect the experiment results. Furthermore, it is advised to utilize proper laboratory equipment and measuring devices to ensure the reliability of the data collected from the procedures. The usage of other abundant crops with more fiber and cellulose content could also be considered for its strengthening properties. If the researchers cannot follow the recommendations above, getting additional guidance and insight from professionals with expertise in the chosen field of research are recommended.

### *4.5 Implications*

The overall result of the research can benefit future research conducted within the same field. The testing procedures and data collection process can be modified to create a variety of paper utilizing locally available fruit peels, waste, and other fibrous alternatives to wood fiber. In creating this end-paper, the researchers were able to recycle previously used paper and household waste products to emphasize the importance of the trees in the environment and aid in the minimization of waste. This concept subsequently contributes to the well-being of the whole community and improves the state of waste management.

## 5. ACKNOWLEDGMENTS

First and foremost, we would like to thank the Lord our God for the safety He provided for us amidst the global pandemic. Through His protection, we pursued our research endeavors and slowly contributed to a waste-free community and world.

We would also like to extend our most sincere gratitude to our family, particularly our parents, for giving us financial support and allowing us to purchase the necessary research materials online. Through their endless love and support, we were able to perform our research experiment and smoothly test our hypothesis.

Last but not least, this research would not



have been possible without the support and guidance of our Inquiries, Investigations, and Immersion subject teacher, Mr. Lodeo Pascual, and our research advisors, Mr. Kevin Villarico and Mr. Nico Bravo. Their insights and expertise in the scientific field significantly contributed to and improved the overall state of this research project.

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2020-2021

MATERIALS ENGINEERING

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## Design and Analysis of a Face Mask Alternative

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**Abstract:** Due to the recent pandemic that plagued the country, face mask disposal has gained considerable attention. If something similar were to happen again, the creation of an alternative to the medically approved surgical masks is crucial to minimize disease spread induced by improper face mask disposal. This study aims to analyze and determine the proposed output's effectiveness compared to conventional face masks. The materials for the trilayer output were nylon, paper towel, and cotton. The produced output and the control sample, the standard cloth mask, were sent to a lab for water resistance and absorbency tests. The test results revealed that neither the produced output nor the cloth mask could meet the recommended standards of a good face mask. As such, this research concluded that the production of an alternative face mask using the materials stated above in a manner identical to that of this study is ill-advisable. Additionally, the study affirmed that the standard cloth masks are not suitable as an efficient alternative to surgical masks. Overall, the paper intends to contribute to solving two of the United Nations' Sustainable Development Goals (SDG), which are (3) Good and Health Well-being and (12) Responsible Consumption and Production.

**Key Words:** face mask; alternative; resistance; absorbency; substitute

### 1. INTRODUCTION

Given the rapid spread of COVID-19 cases globally, the community's active population must use efficient face masks to mitigate virus transmissions. In a study conducted by Cheng (2020), countries with high compliance with face mask usage, such as Hong Kong (96.6%), have lower cases within the first 100 days of the virus exposure. From this, it can be concluded that community-wide mask-wearing has an inverse relationship with the number of transmissions.

As face masks have been proven to be an effective measure in preventing transmissions, Wu (2020) adds that the usage of face masks has become the global norm. With this in mind, billions of face masks have been produced and used yearly by various countries. Taiwan has consumed 1.3 billion surgical masks in one year. Sangkham (2020) also cites that each person in the general population used one face mask each day. On that note, improper disposal of infectious wastes, such as used face masks, may negatively impact both health and environment-related aspects.

To combat this problem, identifying sustainable and easily accessible materials for face mask alternatives is of great significance to the community. Thus, the researchers aim to create a better community face mask alternative in place of cloth masks by having it tested by laboratory professionals. Moreover, the study intends to assess,

analyze, and determine the produced output's effectiveness compared to conventional face masks.

The materials for the output were nylon fabric, paper towels, and cotton. These materials were utilized based on determined criteria and accessibility in the perspective of an ordinary Filipino. In this manner, the researchers conducted tests to examine their efficacy in resisting water, preventing the entry of bacteria, and exhibiting comfortability.

### 2. REVIEW OF RELATED LITERATURE

The production of a community mask alternative with comparable effectiveness calls for being equipped with prior knowledge on related studies. Consequently, the researchers explored trusted sources to gain useful supporting information on the topic.

In his study, Cheng (2020) proved that community-wide mask-wearing has an inverse relationship with the number of transmissions. Countries with high compliance with face mask usage have significantly lower cases than those with low compliance. In this manner, the number of COVID-19 cases can be mitigated (Guan, 2020).

Unfortunately, a multitude of studies deals with existing face mask alternatives and their efficiency. Still, only a few were able to tackle the actual materials used for different types of masks. It is crucial that we further investigate the effectiveness of such materials. Likewise, understanding the



scientific properties behind the materials of existing face masks shall lead the researchers to identify critical points for alternative face mask production. Apart from this, studies related to suggested face mask homemade alternatives were considered. This is crucial as Khazan (2020) claims that people's daily activities will include face masks as necessities for a long time due to the pandemic.

Lastly, elaborating different processes of contamination measurement through valid sources led to helpful knowledge to create a scientifically accurate and acceptable experimental design to test the researchers' output.

As for the materials to be tested, common household materials that observe excellent filtration efficacy, particularly coffee filters and vacuum cleaner bags, were selected. Moreover, a study conducted by Davies (2013) suggests using breathable materials such as cotton and silk.

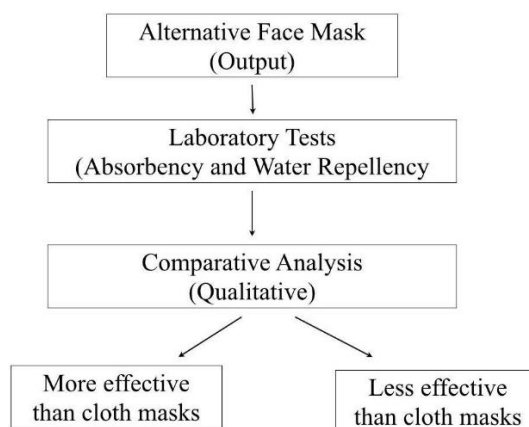
In the context of nylon fabric, Godoy (2020) claims that research suggests that adding an outer layer of nylon fabric to a homemade cloth face mask can increase its filtration efficiency. Accordingly, layers can potentially make the pre-made face mask comparatively similar to surgical masks.

According to Mayo Clinic (2019), cotton-made cloth masks are intended to trap droplets released from the wearer's mouth while observing superiority in terms of comfortability. In this manner, these masks can reduce the spread of external agents and viruses without compromising the wearer's comfort. Moreover, cloth face coverings are easily accessible by the community. These masks can also be easily rewashed and reused.

On the other hand, a single sheet of paper towels shows an unpromising 23% 0.03 micron particle blockage after a test by Robertson (2020), which adds 10% for an additional layer. However, Parker-Pope (2020) from The New York Times asserted that inserting a paper towel in the middle of two fabrics can make the mask more efficient and effective.

### 3. METHODOLOGY

In this study, data was collected through laboratory testing protocols. A prototype of the proposed output and a standard commercial cotton mask were sent to Intertek Laboratories for experimentation. Licensed laboratory professionals conducted the tests to determine how efficient each face mask performs, given the criteria.



#### 3.1 Absorbency

The data gathered for the face masks' performance in absorbency was obtained through an Absorbency Test (AATCC 79). As stated by the American Association of Textile Chemists and Colorists (2018), this test method applies to any textile fabric as it determines its water absorbency. Therefore, it is suitable for measuring and comparing the two face masks' absorbency to gauge how they minimize skin moisture and facilitate sweat evaporation.

In this test, a drop of water was allowed to fall from a fixed height onto the fabrics' surface. Moreover, the time taken for the water drop to disappear and evaporate was measured and recorded as wetting time.

#### 3.2 Water Resistance

The data gathered for the face masks' performance regarding water resistance was obtained through a Water Repellency Test (AATCC 22), also known as Spray Test. As stated by the American Association of Textile Chemists and Colorists (2017), this test applies to any textile fabric, as it measures its overall resistance to wetting by water. Therefore, it is suitable for measuring and comparing the water-repellent efficacy of the two face masks.

In this test, water was sprayed against the fabric surface under controlled conditions. This, in turn, produced a wetted pattern whose size varies based on the fabrics' relative repellency. Upon doing so, the wetted pattern was compared with pictures on a standard chart for further evaluation.

#### 4. DATA AND RESULTS

Item Description	: Two (2) submitted mask marked as: (A) woven in white with green embroidery (outer side) and white pique (inner side) with 6 white panels (B) knitted in black with red print (outer side), white (inner side) with 3 white panels.
Date Received/Date Test Started	: 17 November 2020
Fiber Content	:
Color	: (A)White, (B)Black
Order No.	:
Article No.	:
Style No.	:

Based on the results shown above, both the experimental group (A) and the control group (B) failed to meet the standard in terms of water repellency. As the required remark is 70, which involves a partial wetting of the specimen face beyond the spray points, both groups (A and B) had 0 remarks due to their complete wetting upon testing. In the said experiment, three trials were conducted on both A and B. However, the results remained constant at 0. This means that the percent error of both samples is at 100%.

Moreover, the results show that the produced output (A) did not have water resistance levels more than or equal to standard cloth masks.

Water Repellency Absorbency Test	(A) F**	(B) F**
	F**	F**

Note:  
 P = Passed the Commercially Acceptable Requirement.  
 F\* = Failed the Commercially Acceptable Requirement.  
 # = No Specified Requirement.  
 # = No Submitted Information  
 MI = Meet the Submitted Requirement. F1 = Below the Submitted Requirement  
 M = Meet Buyer's Requirement. F = Below Buyer's Requirement

1. Water Repellency		(A)	(B)	Requirement
AATCC TM22-2017e		Outer Side	Outer Side	
Rating	Trial 1	0	0	70
	Trial 2	0	0	70
	Trial 3	0	0	70

REMARK:  
Tested on Panels

Legend:  
 100 = No sticking or wetting of the specimen face  
 90 = Slight random sticking or wetting of the specimen face  
 80 = Wetting of specimen face at spray points  
 70 = Partial wetting of the specimen face beyond the spray points  
 50 = Complete wetting of the entire specimen face beyond the spray points  
 0 = Complete wetting of the entire face of the specimen

The results acquired from the laboratory in the context of absorbency show unsatisfactory results. The standard for water absorbency was not met; additionally, the control test results were shown to be much closer to the standard than the produced output. The produced output falls short of both the control group or the generic cloth mask and the recommended standards in terms of water absorption.

To expound better, the water absorbency in this test was measured in terms of time, wherein the amount of time (in seconds) it takes for the fabric to absorb a particular volume of water was measured. The time it took for the cloth mask and the produced output to absorb water was eight seconds and more than 60 seconds, respectively. This means given the required time is five seconds, the control had a percent error of 60%. Meanwhile, the produced output had a minimum percent error of approximately 1100%.

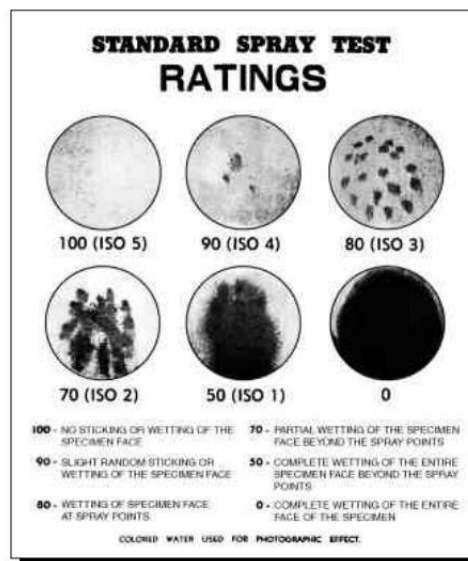


Fig. 1—Spray test rating chart.

2. Absorbency Test		(A)	(B)	Requirement
AATCC TM79-2016e2(2018)e		Inner Side	Outer Side	
		60 + s	8 s	≤5 s

REMARK:  
s = seconds  
Tested on Panels

#### 5. CONCLUSIONS AND RECOMMENDATIONS

The study has concluded that the produced output is, in fact, less efficient than the standard cloth mask as a whole. The produced output falls short of the standards put together by the World Health Organization (WHO) and the properties of the cloth mask found in markets. As such, the materials used in producing the output—the nylon, the tissue paper, and the cotton—are ill-advised to be used, or at least to be used in the same manner as that in the study to produce an effective alternative face mask.

Given that the output could not be tested with certain criteria, such as filtration efficiency, flammability, and air permeability, which is crucial for a face mask, future researchers must consider this. It is necessary as these specific criteria are firm fundamentals for the effectiveness of a face mask. Additionally, it is also advisable for the manner of testing to be conducted by future studies to be more systematic and reliable than the method done in this study. A more reliable way of conducting the research would have been to test multiple samples of varying materials one by one and then produce an output, which would also be tested based on the results.

Moreover, citizens must be advised that commercially available cloth masks also performed poorly in the test. In conclusion, surgical masks are still the best option.





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## Sino malaya?: Melodrama and the Integration of Contemporary Social Issues in Philippine Independent Films

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**Abstract:** Various film critics have written about the dominant themes found in independent films, such as gender and sexuality, culture, and sociopolitical issues. Independent filmmakers have distinctive ways of portraying these issues. Guided by Pathak (2017)'s framework on melodrama, the researchers chose to use melodramatic conventions and techniques to analyze further how these social issues are portrayed in independent films. Findings found that the independent films used melodramatic conventions in portraying social issues. Analyses showed that (1) the films made use of issues such as family relationships and understanding reality, (2) various cinematic elements were applied in the context of melodrama to deliver the film's message, and (3) setting and physical characteristics were utilized in independent films to display social issues better. This study may be relevant to future research on independent film analysis, the development of national cinema, and the progress of local independent films as a whole.

**Key Words:** independent films; melodrama; contemporary social issues; Philippine cinema; films

### 1. INTRODUCTION

To understand the contemporary issues in independent films in the Philippines, the researchers interpreted the issues through analyses of films in the genre. The concepts of what elements are included in the creation of independent films were analyzed. These were essential in understanding the need for these social issues to be addressed and if the future of Philippine cinema would be rooted in the country's troubles. The researchers used Philippine independent films, which are individually funded and produced, with little to no outside regulation that commonly deal with real social issues widely faced by third world countries such as the Philippines (Beng, 2010; Isla, 2010).

#### 1.1. Background of the Study

In the 21st century, films remain one of many individuals' major leisure activities (Heo et al., 2017). Filmmakers and production companies continue generating endless possibilities when creating films. Notably, independent films have been 'breaking the scene' and are contesting movies by major film companies. Independent films are unique in how filmmakers deviate from standard techniques and methods, all amidst a limited production budget and manufacturing staff (Lim, 2019). In the Philippines, independent films have made their way into mainstream cinema, garnering numerous viewers and supporters. The content of these films aid in acquiring

audiences, with the most popular themes being gender and sexuality, culture, and sociopolitical issues. These subjects are essential since independent filmmakers risk tackling more challenging sociopolitical problems to shed light on current, pertinent issues (Bolisay, 2017). Through viewing independent films, audiences obtain new knowledge that sheds light on the present societal situation.

#### 1.2 Statement of the Problem

This research aimed to analyze the content of independent films by answering the following questions:

- What are contemporary social issues commonly portrayed in independent films in the Philippines?
- How do conventions in melodrama influence the portrayal of these contemporary social issues?
- How do cinematic elements work through the portrayal of these issues in independent films?

#### 1.3 Scope and Limitation

The researchers focused on analyzing contemporary social issues in exclusively Philippine independent films, using melodrama conventions and cinematic elements. A thematic analysis was conducted on three independent films from different local filmmakers. The analysis was based on techniques elaborated in Braun and Clarke (2012) and limited to melodramatic scenes and contemporary



social issues found in the films. The data was used to determine similar codes in the movies that eventually led to discovering their respective themes.

### *1.4 Significance of the Study*

Independent films have been rising in recognition throughout the years, providing a platform for filmmakers to explore unconventional ideas, deviating from mainstream media (Bolisay, 2017). Independent films are a way to present social issues in a consumable form, as the discussion and awareness thereof are vital. Moreover, the usage of melodramatic conventions, a common technique used in Filipino media, aids in understanding how independent films with melodrama will contribute to the comprehension of how much of an impact independent films have on society (First, 2008).

The results also established the importance of independent films and the social issues being portrayed. The researchers hope that this study could contribute to the sphere of the arts as a whole.

## 2. METHODOLOGY

The researchers' methodology made use of Philippine independent films that were showcased in public events. A total of three films were selected from two different directors, which all contained various social issues present in the Philippines. Then, data was gathered from these films and were analyzed using the thematic analysis method of Braun and Clarke (2012).

### *2.1 Films Analyzed*

In selecting the films to be analyzed, the researchers chose those presented in public film festivals like Cinemalaya. According to Bolisay (2017), the increase of such events that offer screening venues led to a similar increase in independent films, which is why the researchers chose this as a selection criteria. They sent request emails to local independent filmmakers who had films that fit this criterion. Given that some were unresponsive, the researchers looked for alternative sources such as legal streaming sites. Once the list of films was finalized, the director, synopses, and initial social issues were tabulated as a guide.

### *2.2 Data Analysis*

The researchers used Braun and Clarke's (2012) thematic analysis method in interpreting the data that came from the movie analyses. They identified common ideas and patterns evident in the films and distributed them into codes per individual film. These codes were categorized into general themes based on their similar characteristics.

Afterward, the research questions were answered using the themes that were collected.

## 3. RESULTS AND DISCUSSIONS

Four still images from each of the three movies, *Transit* by Hannah Espia, *Lola Igna* and *Pamilya Ordinaryo* both by Eduardo Roy Jr., were collected by the researchers to provide scenes that both utilize melodramatic conventions as well as portray the social issues presented by the film.

### *3.1 Lola Igna*

*Lola Igna* portrayed themes and issues through various cinematic elements and melodramatic methods, such as landscape and positioning as narrative tools. The slow scene pacing and the use of natural sounds presented the simple provincial life of the main character. On the other hand, the camera movement was also manipulated for symbolisms. Contrasting static shots and "vlog" shots were utilized to portray the degree of connection certain characters and the audience had with the title character.

Symbolisms were also evident in dialogue, *mise-en-scène* and cinematography. This was showcased in the use of language variation to portray *Lola Igna's* opening to new experiences, the placement of insects to show the theme of death, and the penultimate final shot that represented both the life and newfound resolve of the title character.

### *3.2 Pamilya Ordinaryo*

*Pamilya Ordinaryo* depicted the lifestyle of the Filipino poor and focused on the reality of living as beggars and their treatment in society. The film portrayed the realities that the poor have to deal with, such as maltreatment by members of the sectors of society, the higher tendency of drug abuse, and the need to live for survival.

Melodrama was implemented to create a connection of empathy between the audience and the characters, showing the side commonly known by most and the struggles faced by the *Ordinaryo* family and, in turn, the poor in the Philippines.

The ambiance of the shots used no filtering to glamorize the scenes; instead, it used background noise and realistic settings to depict the scenarios familiar to viewers. As seen in the still images, the dialogue was manipulated, often taking advantage of the silence or carefully chosen words to portray the emotions the characters feel in that moment. This movie effectively used the tools of melodrama to show what life was like for those in poverty and captured the audience's attention, raising awareness of the difficulty of surviving every day and changing how one perceives a beggar on the street.



### 3.3 Transit

Transit is a film that showcases the vast experiences of both OFWs and their children working in foreign lands. Most scenes used close-up to half-body shots, which followed each of the different storylines. Throughout most of the film, each scene was filmed with many gray tones, resembling bleak situations. The film utilized the different perspectives of the main characters to add new information and views regarding the issue.

The film allowed the audience to better understand the problems faced by OFW communities and learn more about the specific issue of deportation in Israel as both had significance to the nation's culture and economy. The children could not fully identify with their Filipino heritage due to the vast difference in their upbringing while also being unable to identify with the Israeli society due to their ethnicity. The adults also dealt with the deportation problems. These characters were being rejected by the country they were in while also leaving the hardship they would have on their return, which is a commentary on the country's labor quality.

### 3.4 Discussion

Based on the preliminary analyses of the still images, these scenes were categorized into different codes used to determine dominant themes according to each research question.

#### 3.4.1. Social Issues

The themes of family relationships and understanding reality were drawn. First, the narrative of the films revolved around families. Lola Igna showed how her provincial family affected her everyday life and will to live. Pamilya Ordinaryo followed the daily struggles of a poor teenage family. Meanwhile, Transit explored the living conditions of illegal immigrant families. These films emphasized their dynamics and how they dealt with the problems they faced.

The family structures and relationships presented were in contrast with mainstream media's norms. Clark (2008) described American family movies as "middle-class, Caucasian, dual or single-parent family with one or two children" (p. 85). The chosen films deviated from this concept of family. Families in different settings, different classes, and different problems from the image customarily portrayed were seen in all films.

In line with this, realism was quite evident in the films analyzed. Unlike mainstream media, these independent films showcased realistic living conditions and stories. Zurcher, et al. (2018) discussed that many mainstream films portrayed families in positive environments. Despite promoting good family relationships, these lack in reality. The films chosen

not only showed real family conflicts but also individual journeys. The characters had to come to terms with the purpose of life, power imbalance between classes, and realistic consequences of their actions. These independent movies delved into issues and topics ignored by mainstream media.

#### 3.4.2. Melodrama Conventions

Melodramatic conventions were utilized by presenting situations relating to the audience and drawing emotion through symbolism. With the filmmakers giving environments familiarity, a connection and empathy was formed between the characters and viewers. Pamilya Ordinaryo and Lola Igna were set in familiar environments while Transit was shot in unfamiliar Israel, which allowed viewers to see the unique circumstances of characters.

The cinematography in the films utilized the technique of stabilization in filming, with some melodramatic scenes shot in still, wide shots with little movement to portray the filmmaker's intended messages. Point of view helped emphasize who the audience identified with (Håkansson, 2012). There was also a sense of composition in scenes, found by Callenbach (1966) to be one of the critical components of cinematography. This was seen in how Lola Igna and Transit scenes were shot, creating an artistic quality in the scene serving a more profound meaning from the beginning to the end.

Landscapes and color were also important since they changed the film's atmosphere, as seen in the difference from the streets of Manila of Pamilya Ordinaryo to the province of Lola Igna, and even urban Israel in Transit. The dark colors of Pamilya Ordinaryo and Transit to Lola Igna's cheerful and natural elements, allowed the audience to become a part of the story.

Symbolism was also a key melodramatic element. Bakony (1974) asserts that symbols are the combined conscious and unconscious associations by the viewer. The films utilized multiple visual and verbal symbols that portray deeper messages, as independent films place importance in storytelling to deliver their stances.

#### 3.4.3. Cinematic Elements

Drawing from codes cinematic elements were utilized to portray issues by reflecting circumstance in setting and character status in physical characteristics. Though each film showed different circumstances, each film adjusted the portrayal of the settings to fit the movie's theme.

Setting is a primary tool for social issue portrayal in films, allowing filmmakers to introduce themes through character interactions in an environment. Time and place, interact with one another in a film to portray a specific narrative



(Pramaggiore & Wallis, 2005). These settings exposed many previously unknown areas such as the rural Sagada, the slums of Manila, and Filipino housings in Israel. These inform viewers about the characters' lives and form an emotional connection to these places through momentary experience (Frost, 2009). Each film evoked an emotional response through the settings that showcased the characters' contexts and motivations.

The way characters carried themselves through personal adornment or interaction with others also allowed the film to portray their messages. All three films showed characters that lack money to buy clothing, symbolizing the characters' bleak financial status (Batten, 2010). The dialogue between characters also allows viewers to understand the emotional connection between characters and see the different ways of speaking and relatedness among the different groups of people (Azab et al., 2019). Character intimacy was also shown in both dialogue and proximity, allowing viewers to see that the theme of family is prevalent in different circumstances.

#### 4. CONCLUSIONS

The three Philippine independent films analyzed used various cinematic elements and melodramatic conventions to portray their respective social issues. The different types of Filipino family dynamics were depicted, including realistic and flawed characters and situations. When it came to melodramatic conventions, the independent films presented situations with the audience and drew emotion through symbolism. Setting, cinematography, landscapes and color, and symbolism played essential roles in creating a connection with the audience and developing the story. Lastly, the cinematic elements evident in the films were setting to reflect one's circumstance and portrayal of character status through physical characteristics. The characters were defined by their setting and their interaction with other characters.

Through the rising popularity of independent Filipino cinema, filmmakers are given more freedom to express their views on social issues occurring in the country. Their works continuously inspire and motivate audiences nationwide, creating wiser and more knowledgeable audiences. Truthfully, Filipino independent films act as a common ground for both artistic expression and social awareness.

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## Perceptions of Parents' Attitudes towards Activism and its Impacts on the Political Behavior of Undergraduate Student Activists

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**Abstract:** This paper seeks to study student activism by focusing on how parents' perception of their activism affects their political actions and decisions. Six students from three undergraduate student activist organizations across Metro Manila were purposely sampled to participate individually in a semi-structured interview developed around the concept of attitudes categorized into three components: the behavioral, the cognitive, and the affective. Thematic analysis reveals that parents generally tend to negatively perceive activism, which does not necessarily affect students' decision to continue activism despite accompanying emotional burdens. The findings ascertain that parents employ various parenting styles from rational to authoritarian and emotions such as worry and rage in reaction to their child's activism. Moreover, the participants were found to apply values such as tireless persuasion and discretion to negotiate conflicting perceptions of their activism with their parents.

**Key Words:** student activism; political socialization; political behavior; perception; parental attitudes

### 1. INTRODUCTION

#### 1.1. Overview

In the 21st century, there has been substantial growth in the number of youth political activists; however, due to a heating political climate nowadays, adults – especially the parents of youth political activists – have second thoughts on this rapid uprising (Madarang, 2019; Pedrajas, 2021). It has been common knowledge that parents have a significant role in shaping and guiding their offspring's political views and involvement (Davies, 1965). The directness in youth political activism has paved the way for notable contributions to Philippine independence (“APPENDIX: A history,” n.d.; Palafox, 2012). In the present, numerous student protest organizations still exist in pursuit of nationalism by expressing their stand on social issues (“Akabayon Youth,” n.d.; “Anakbayan PH,” n.d.; Moreno, 2020; “SALiGAN sa CSSP,” n.d.). Several different factors influence political activism on the youth; however, participation in such activities may also be affected by how parents perceive their children's actions (Gordon, 2008). This paper seeks to study the phenomena of student protests from the context of the Filipino family with a focus directed at the perceptions of student protesters towards their parents' attitudes.

#### 1.2. Participants

The researchers seek to answer their research questions by conducting a semi-structured interview

with purposive sampling targeting the population of undergraduate activist organizations in Manila. Four participants were from Anakbayan PLM, one from Akbayan Youth - UP Diliman, and one from SALiGAN sa CSSP, accounting for a sample of  $n = 6$ . Five participants had parents who were aware of their activism, while one had parents who were unaware.

#### 1.3. Significance of the Study

This study will benefit the following people and institutions: student activists and their parents, schools, and future researchers. It will provide student activists' accounts of their parents' attitudes towards activism. Thus, it may help both parents and students understand each others' insights so both parties can communicate better. Schools may disseminate findings from this study regarding student activism to their student's parents and the student body. Moreover, future researchers may use this study as a reference as it contains new insights from student activists in prominent universities in the Philippines.

#### 1.4. Research Questions

Socialization has piqued the youth's interest in political activism and even led to significant contributions to the country's independence. Davies (1965) postulated that this molding occurs in childhood mainly through their family --- and as the youth get older, they usually disassociate themselves from the mindsets of their family and engage more



with their peers. Montiel and Chongbian (1991) deduced that parents had influenced their children's political values during the Martial Law period. However clear it may seem, there are still gaps left in understanding the prominence of parents' attitudes to their children's political interests. The following research questions serve to clarify the gaps:

- R1: How do parents' attitudes towards activism affect political actions and behaviors?
- R1.1: How do parents of undergraduate student activists perceive "activism"?
- R1.2: How do these perceptions impact the decisions of undergraduate student activists?
- R1.3: How do undergraduate student activists negotiate conflicting perceptions with parents?

## 2. METHODOLOGY

Data was gathered in a semi-structured interview format, with each participant interviewed separately. The interview format makes for more in-depth discussions about personal and social issues that may be more difficult to discuss in a group setting (Di Cicco-Bloom & Crabtree, 2006). Thematic analysis was used to comprehend the experiential data by identifying common themes observed across most of the interviews (Braun et al., 2019). Two main processes were used under thematic analysis: coding and theme searching. Codes were developed through individual interpretations of the researchers, with one meeting to finalize the codes and assign them to their respective themes. The criteria for codes to be considered relevant are present in at least two out of the six interviews. The questions asked in the interview require the respondents to provide personal information about family issues. Therefore, the researchers provided an informed consent form to prevent any ethical breaches in data collection.

## 3. RESULTS AND DISCUSSION

Table 1. Synthesis Table for Codes and Themes

Perceptions of Parents Attitudes			Impacts on Political Behavior
Cognitive	Affective	Behavioral	
Acknowledgement of Red Tagging of NDMOs	Passive Acceptance of Children's Activism	Conditional Recognition of Children's Activism	Risks on Mental Health
Limited Understanding/ Experience of Activism	Developing Sense of Inquiry and Curiosity to Activism	Emotionally Detached Parenting Style	Tireless Persuasion Activism as Fulfillment of Parents' Teachings
Perception of Activism as "Brainwashing"	Fear for Children's Safety	Rational Parenting Style	Discretion and Lying to Parents
Activism as a Public Nuisance	Rage over Children's Decisions	Authoritarian Parenting Style and Emotional Blackmail	Family having little to no impact on Political Decisions

The researchers developed four themes based on thematic patterns seen among the codes of the six interviews: the cognitive, affective, and behavioral

components of the parents' attitudes (Fishbein & Ajzen, 1977) and their impacts on the political behavior of their children. The cognitive discusses the beliefs and perceptions of parents towards activism. The affective deals with their emotional reaction while the behavioral addresses their actions. The impacts on political behavior mainly deal with psychosocial effects and the political decision-making of the activists.

### 3.1. Cognitive Component

Almost all interviewees mentioned their parents' immediate negative perception of activism fueled by the prominence of red-tagging. First, they believe there is an underground movement that creates terrorists. Hence, they develop a weariness for their children to join rallies, as they consider it a slippery slope into the movement. These are similar to the beliefs of anti-communist, parent-based organizations, League of Parents in the Philippines (LPP), and Hands Off Our Children. Second, parents have a limited understanding and experience of activism, which leads them to reiterate popular stereotypes. Their children usually face resistance in political discussions due to their pro-administration, centrist, or apolitical leanings. Third, parents perceive activism as "brainwashing" rather than as a legitimate political choice. This perception leads to the belief that their child is in a danger they are not aware of, supported by Filipino parental ethnotheories that conceive the child as unable to develop self-control and reason yet (Alampay, 2014). Furthermore, similar to Di Cicco's (2010) public nuisance paradigm, parents perceive activism as a nuisance to the country, questioning why activists look for problems when there are none.

### 3.2. Affective Component

Participants who perceive that their parents' overall feelings concerning the participants' activism are generally positive indicate that their parents respond passively. Some parents expressed this in the following manner:

...basta raw 'di nakakaapekto sa acads ko and 'di ako nadidistract masyado. (trans. ...as long as it does not affect my academics and I don't get too distracted.)

Kebs lang naman sila. (trans. They're usually just fine with it). [Kebs is an affirmative slang term that refers to "whatever".]

Parents' feelings were also in the form of curiosity. Some participants indicated that as time progressed, parents became accepting towards their children's activism and eventually acquired a sense of inquiry regarding what specific activities their children participated in.





Regarding those who declared that their parents have a generally negative feeling towards their children's activism, some participants stated that their parents usually have a sense of fear or worry when faced with the prospect of their children being youth political activists. One of the parents quotes: "Baka barilin ka ng mga sundalo. (trans. Soldiers might shoot you.)"

Another emotion expressed is rage, which is usually in the form of confrontational questions, threats, and ad hominem. As one participant said, "Minsan nagkakaroon ng mga argument na may kasamang ad hominem. So hindi nagiging maganda yung effect ng differing political stance dito sa bahay. (trans. Sometimes there would be arguments with ad hominem. Thus, differing political stances in this house do not have a positive effect.)"

### *3.3 Behavioral Component*

The respondents discussed their parents' behavior towards their activism positively and negatively based on the amount of freedom they were afforded. Parents generally allow their children to join activist organizations and related activities as long as they ensure their safety and maintain good academic performance.

The difference in parenting styles also affected the quality of freedom and support given. A respondent's parent who has a "rational parenting style" allows them to have independent political views and tries to listen and share their child's feedback and opinions, even if they have contrasting ideologies. On the other hand, emotionally detached parents do not get involved with their children's activities but still try to show affection in subtle ways, such as supporting their children financially and occasionally checking upon them. This is viewed as positive by the respondents because, ultimately, they still have the freedom to join mass organizations. An authoritarian parenting style is judged negatively by respondents as parents warn their children not to join activist organizations. They also mentioned that they got emotionally blackmailed by their family for being part of movements.

### *3.4 Impact on Political Behavior*

Two interviewed participants described their behavior is motivated by their mental health. One participant's veteran grandfather called him to say, "You will be targeted and you will be killed." because of his activism. This led the participant to break down crying, and he adds that he would sometimes avoid political discussions with his parents because of the toll on his mental health. Another participant describes fears that "Papalayasin ako ng magulang ko." (trans. My parents would disown me.) after coming out to her parents as an activist, which is

consistent with Dela Cruz's (2001) and Jocano's (1970) research on "disiplina" and punishment

Participants with parents who are non-supportive about their activism and who hold control over their movement talk about how they have practiced being discreet about their activism. One participant frequently lied about going to her friend's house when attending organization meetings and activities, while another described slipping away from their home to join a rally. If they do not choose to be discreet and decide to tell the truth, some fear that they will not be allowed or that they would be grounded as a result. The use of discretion and lying replicates the findings of Gordon (2008) regarding the similar strategies of young female activists; however, this does not mean that they hold ill intentions towards their parents.

As another participant says, "Hindi tinuturo sa pagiging aktibista ang pagiging suwail na anak." (trans. Being an activist doesn't teach you to be a disrespectful child). He brings up how his organization has a specific educational discussion entitled "Parents and Activists" based on writings by Constantino (1971). He adds that he sees his activism as fulfilling his parents' teachings to him. One interviewee expresses her desire to become emotionally closer to her parents after coming out as an activist.

Most of the activists interviewed see tireless persuasion as their response to the conflict. They progressively explain their organization, activities, and political ideology while engaging in discussions about social issues with their parents. This is in line with Mcdevitt and Chafee's (2002) model of trickle-up socialization, where children can influence the political socialization of their parents. Part of the persuasion is also proving how the activists can maintain their grades, do their chores, as one participant puts it, "kahit member ako" (trans. even if I'm a member) which is in line with Medina's (2001) conceptualization of the numerous practical responsibilities of the child to the family based on "utang na loob."

Despite family influencing political behavior, most participants believe that family opinion has little to no impact on their decision to continue activism. This is because those interviewed either live separately from their parents, have parents with rational or detached parenting styles, or are discreet about their activism. These reasons are either strategies that address the authoritarian influence of Filipino parents (Dela Cruz et al. 2001; Jocano, 1970; Sicat, 1976), or circumstances that avoid it altogether.

## **4. CONCLUSIONS**

An overview of the results and discussions shows the conflicting nature of parents' attitudes towards activism. Their cognitive perceptions are



susceptible to being informed by black propaganda and red-tagging activists as terrorists due to their limited understanding of activism. This is likely due to their Filipino socio-cultural environment, which informs their psychological processes and attitudes (Torney-Purta, 2004). This is supported by the general prominence of red-tagging in the Philippines by parent-based organizations and state efforts, and parental cultural beliefs.

As a consequence of their cognitive perceptions, parents behave and emote accordingly with the strictness or looseness of their parenting style, while their emotions towards activism constitute a range of passive acceptance, fear, or rage. Although the interviewed activists feel that their parents' attitudes burden their mental health in the form of anxiety and increased emotional burden, these attitudes have little impact on their overall decision to continue as active members of their organization.

In navigating the conflicting perceptions of their parents, most of the participants applied a strategy of discretion and tireless persuasion to pursue activism despite their parents' opposition and to challenge the political beliefs of their parents contrary to traditional Filipino family beliefs and power structures (Alampay, 2014; Montiel and Chongbuan, 1991). In their tireless persuasion, they see their parents as part of the masses rather than adversaries, and they understand activism as an extension of their parents' teachings. The researchers conclude that even as the conflict may further separate activists from their parents, the intentions of activists are rooted in mending this conflict rather than exacerbating it with their love and respect of their parents underlying their actions.

#### 4.1. Recommendations

Based on the findings, there were several recommendations that researchers can consider for future studies and application.

Since all participants were situated in Metro Manila only, it is suggested that researchers widen the scope to undergraduate student activists in different universities across the Philippines to understand the national situation regarding student political activism and parents' perception of such.

This study merely focused on identifying the phenomena of student activism and political attitudes through parents' perceptions. Thus, the researchers call future researchers to consider several other social relationships that influence the behavior of student activists concerning their activism.

Lastly, the researchers submit that succeeding research should focus on whether parents' perceptions significantly affect Filipino student activists' tendency to participate in the different levels of activism, which may include dutiful, disruptive, and

dangerous dissent, as stated by O'Brien et al. (2018).

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## Nationalism and Social Advocacy Amongst Select Generation Z University Students in Metro Manila

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**Abstract:** Nationalism and Social Advocacy are two aspects that build the youth's collective social and political identity. This study focused on identifying the significant relationship between nationalism and social advocacy amongst 35 select Generation Z university students. With the use of the ISSP National Identity Module 2013 Edition and the Social Issues advocacy scale, the respondents' nationalism and social advocacy levels were defined, respectively. Along with a letter of informed consent, both scales were embedded and distributed using an online survey tool to individuals that fit the inclusion criteria within Metro Manila. The results were analyzed and organized using the Pearson R Correlation test and descriptive statistics per variable, under the SPSS Statistics tool ver. 27, to determine the possible relationship between these two variables. The findings show that select university students have a high level of nationalism and social advocacy, and a strong positive significant relationship was found between the two variables. In addition to this, the direct relationship between both variables may indicate increased civic engagement, hence the recommendation of studying either variable in political activism amongst the youth or another field of university students in Metro Manila.

**Key Words:** nationalism; social advocacy; national identity; engagement; activism

### 1. INTRODUCTION

It is essential to realize that the study of nationalism is more than just a citizen's love for their country. Bonikowski (2016) perceives nationalism as part of daily human behavior rather than a political ideology. The internal sense of nationalism may be related to an individual's sense of advocacy or external action. The research study of McInroy and Beer (2020) emphasizes that social advocacy is of great concern to the youth and could be related to their overall national awareness or feelings towards the country.

Although it is acknowledged that there have been studies in the past which tackled Nationalism and Social Advocacy, there remains to be a limited number of previous research studies that focus on the possible relationship between them amongst Philippine Generation Z University students. This idea considers the development of their maturity amidst different social movements (Schwieger & Ladwig, 2018). A study by Fietzer and Ponterotto (2015) acknowledges a particular need to measure an individual's level of social advocacy given the prevalence of social issues. This need also considers the different factors that may affect it, including nationalism, which emphasizes studying the relationship between these two variables.

This research study aims to determine if there is a significant relationship between

nationalism and the level of social advocacy of select university students in Metro Manila. It acknowledges that there is an urgency for the said discussion. Each variable may be the root of social participation from the youth, which is essential in different social issues in the Philippines. The findings of this research shall contribute to the overall understanding and knowledge of nationalism and social advocacy, should a relationship exist between them.

### 2. REVIEW OF RELATED LITERATURE

#### *2.1 Nationalism in the Philippines*

In a socio-cultural approach of nationalism, it impacts particular exclusionary and individual conducts, which is then regarded as a relevant social identity (Latcheva, 2010). A study by Seton-Watson (2019) examines nationalism in political movements that aim to achieve the "national purpose" and how state policies and relationships influence it. Takagi (2016) defines Philippine nationalism as a factor contributing to breaking free from colonialism, especially under the idea that concept studies lean more towards the state's active role in politics, as one's nation depends on nationalism as a basis for policy-making. Additionally, Reid (2010) states that the Philippines is the model for anti-imperialist



nationalism, observed through the country's long history of rebelling against its colonizers, especially Spain.

## 2.2 Social Advocacy in the Philippines

A research study by Barnhardt, Sheets, and Pasquesi (2015) found that those who showed personal advocacies, including nationalism, contributed to building the respondent's social identity. The Social Issues Advocacy scale further supports this view or definition of social advocacy, given the establishment of advocacy to civic engagement (Nilsson, et al., 2011). In the Philippine context, Ty (2011) states that social advocacy may be used as a framework for society in fighting against social injustices in the Philippines. This study shows that the discussion of this concept in the Philippine context is more inclined towards its general social implications rather than its relationship with other fundamental concepts.

## 2.3 Nationalism and Social Advocacy

Research analysis by Pyrhonen (2015) partly looked into the relationship between these variables only in the context of right-wing advocacies. While this study was able to involve the variable of Nationalism through a literature review, it did not discuss the manifestations of such in its respondents and establish a quantifiable relationship with social advocacy. Similarly, a research study by Ahmad, Alvi, and Ittefaq (2019) suggests that an individual's feelings towards a country and its citizens may be associated with their level of civic engagement or social advocacy.

## 2.4 Synthesis

Nationalism and social advocacy have influenced both individual and collective behavior amongst people. In this research, it is understood that nationalism is an aspect of an identity that influences human behavior. On the other hand, social advocacy refers to the pursuit of social justice in civic engagement. Civic engagement is encouraged by a sense of social advocacies, including nationalism, as it helps build one's foundation of social identity. Several studies have used the two concepts in different contexts and perspectives to relate nationalism and social advocacy. However, there are rarely any studies grounded on quantifying nationalism and social advocacy in the Philippine context. Overall, these literature and studies have proven that nationalism and social advocacy play vital roles in the attitudes and perspectives across society, thus being significant towards achieving the research objectives.

## 3. CONCEPTUAL FRAMEWORK

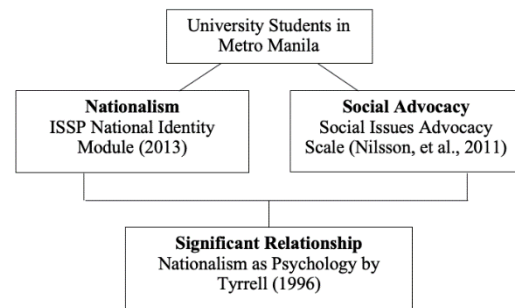


Figure 1. Research Paradigm

The figure presented above represents the research paradigm and conceptual framework of the study. To achieve the study's goal, the researchers plan to measure the variables Nationalism and Social Advocacy using selected research instruments, namely the National Identity Module and the Social Issues Advocacy Scale, respectively. The data shall be gathered from the respondents to suggest an existing significant relationship between the variables, presumably a direct one, and examine such.

## 4. STATEMENT OF THE PROBLEM

The purpose of this study is to determine and discuss if there is a significant relationship between the level of nationalism and social advocacy of the respondents. Hence, the following research questions.

What is the students' level of nationalism given the sum of their survey results under the defined research instrument?

What is the students' level of social advocacy given the sum of their survey results under the defined research instrument?

Is there a significant relationship between the level of nationalism and social advocacy of the respondents?

## 5. METHODOLOGY

### 5.1 Research Design

The research design utilized in this study would be correlational. According to Rodriguez-Bailon, et al. (2017), correlational studies are best used in describing socio-cultural aspects as it leads to a deeper understanding of systematic and social complexity.

With this, the researchers believed that this design was most appropriate for the paper, considering the main objective of this study.



### 5.2. Sample and Sampling

his research study contained thirty-five respondents from different universities across Metro Manila of ranging socioeconomic status. It was a requirement for these respondents to have been a student of a Humanities and Social Sciences related course for at least two years. According to a book by Nussbaum (2010), those with a background in the humanities are more inclined to think critically when faced with nationalistic and social issues. Additionally, it was also a requirement for these respondents to have been citizens of the Philippines for at least five years. This criterion has been chosen based on the analysis of Barrett and Flood (2020). They state that citizenship plays a big role in nationalism due to increased cultural inclusivity and social awareness.

The respondents for this research were selected with the use of a non-probability sampling technique, purposive sampling. According to Black (2010), this sampling technique entails the researchers selecting their respondents given a particular set of criteria. This proved to be most appropriate for this research. The inclusion criteria were verified with two confirmatory questions regarding their course and residency, given the large population of university students in Metro Manila.

### 5.3. Research Instrument

To measure the independent variable or the level of nationalism of the selected respondents, the researchers utilized the publicly available National Identity Module as published by the International Social Survey Programme, 2013 edition. The questionnaire contained twenty-one Likert scale questions that measure one's national identity, ranging from 1 or Strongly Disagree, to 5 or Strongly Agree, given the following statements. An example includes the question, "how proud are you of being Filipino?" For this research, the researchers only selected five of these questions, which were primarily related to nationalism, under the consultation of social science professionals and the advice of the creators of the questionnaire.

As for the dependent variable or the level of social advocacy of the selected respondents, the researchers utilized the Social Issues Advocacy Scale (SIAS) 2011, a twenty-one-item Likert-type scale that measures an individual's social justice advocacy under four subscales. Similar to the previous ranking, the scale ranged from 1 or Strongly Disagree, to 5 or Strongly Agree, given the following statements. An example includes "how often do you participate in your local elections?" It was created by Nilsson, Marszalek, Linnemeyer, Bahner, and Misialek, with validity tested through its empirical comparison to a similar scale (Nilsson,

et al., 2011). The researchers found that the scale was able to measure different aspects of social advocacy reliably.

### 5.4. Data Gathering Procedures

An online survey questionnaire to measure each variable was created for the data-gathering portion. The questions were taken from the identified research instruments, including two questions to define the respondents' demographic profile and an embedded informed consent letter. The survey was distributed within Metro Manila with the use of communication platforms, thus collecting thirty-five respondents.

The researchers ensured their respondents' utmost confidentiality and privacy by asking only the necessary information needed for the research. Rest assured that the gathered data from this study was not and shall not be used for purposes other than this research study.

### 5.5. Data Analysis

Upon gathering the data for the study and organizing these in an excel spreadsheet, the researchers used descriptive statistics to determine the level of each variable. They used the Pearson Correlation Coefficient, as created by Karl Pearson (1896), as the statistical treatment, seeing that all assumptions were met in the results. This was the most appropriate statistical treatment in testing the hypothesis to determine if there is a significant relationship between two variables amongst the respondents, given a specific range (Magnello, 2014).

## 6. Results

In analyzing the gathered data, Pearson's r-Correlation was utilized to determine the relationship between the respondents' level of nationalism and social advocacy.

**Table 1**  
 Demographic Profile: Respondents' Courses and Year level

Course	Frequency	Percentage
AB/BA Communication	2	5.71
AB/BA Creative Writing	1	2.86
AB/BA Early Childhood Education	1	2.86
AB/BA Development Studies	3	8.57
AB/BA Diplomacy & International Relations	8	22.86
AB/BA History	3	8.57
AB/BA Information Design	1	2.86
AB/BA Interdisciplinary Studies	1	2.86
AB/BA International Studies	2	5.71
AB/BA Journalism	1	2.86
AB/BA Philosophy	1	2.86
AB/BA Political Science	5	14.28
AB/BA Psychology	5	14.28
AB/BA Sociology	1	2.86
Total	35	100

**Table 1** Demographic Profile: Respondents' Course and Year Level



Table 1 shows that the respondents came from various Humanities and Social Sciences (HUMSS) college courses, all of which are above the first-year level and qualify for the inclusion criteria. The most common course amongst the respondents was AB/BA Diplomacy & International Relations, with eight respondents (22.86%) coming from varying year levels.

**Table 2**  
 Demographic Profile: Respondents' Year Level in University

Year Level	Frequency	Percentage
2nd Year	23	65.71
3rd Year	8	22.86
4th Year	4	11.43
Total	35	100

**Table 2** Demographic Profile: Respondents' Year Level in University

Table 2 presents the variety of university year levels among the respondents. As shown, the majority of the respondents are 2nd Year university students, with 23 (65.57%) of them being under this category.

**Table 3**  
 Demographic Profile: Respondents' Years of Philippine Citizenship

Years of Citizenship	Frequency	Percentage
18 years	6	17.14
19 years	12	34.29
20 years	9	25.71
21 years	7	20.00
22 years	0	0.00
23 years	1	2.86
Total	35	100

**Table 3** Demographic Profile: Respondents' Year of Philippine Citizenship

All respondents have been citizens of the Philippines for more than five years or the inclusion criteria. The shortest time of citizenship years would be 18 years, with six respondents (17.14%).

**Table 4**  
 Descriptive Statistics on Respondents' Level of Nationalism

Properties under Nationalism	Mean	SD
Importance of Philippine Laws	4.51	0.70
General View on the Philippines and its citizens	17.66	3.40
National Pride	12.17	2.65
Strong Patriotic Feelings in the Philippines	10.60	2.46

*Note.* The data was acquired from the respondents in the middle of the first semester.

**Table 4** Descriptive Statistics on Respondents' Level of Nationalism

The data from Table 4 suggests that most of the respondents' feelings of nationalism come from their General View of the Philippines and its citizens (M=17.66, SD=3.40). This result indicates that nationalism may contribute to their overall national identity and perspective.

**Table 5**  
 Descriptive Statistics on Respondents' Level of Social Advocacy

Properties under Social Advocacy	Mean	SD
Political and Social Advocacy	22.43	6.43
Political Awareness	22.46	5.84
Social Issue Awareness	18.09	3.53
Confronting Discrimination	13.49	2.91

*Note.* The data was acquired from the respondents in the middle of the first semester.

**Table 5** Descriptive Statistics on Respondents' Level of Advocacy

The data from Table 5 suggests that one of the strongest factors contributing to the respondents' social advocacy would be Political Awareness (M=22.46, SD=5.84). Considering the definition of social advocacy in the research instrument, the results may imply that high levels of social advocacy may relate to one's awareness and support of social justice.



**Table 6**

*Correlation of the Respondents' Level of Nationalism and Level of Social Advocacy*

	Total Nationalism	Total Social Advocacy
Total Nationalism	1	.615*
Total Social Advocacy	.615*	1

\* Correlation is significant at the 0.01 level (2-tailed)

**Table 6 Correlation of the Respondents' Level of Nationalism and Level of Social Advocacy**

Table 6 presents the association between the research variables. As shown, the variables are strongly correlated with each other  $r(35)=.615$ ,  $p<.01$ . With this, the data suggests that there is a significant strong positive correlation,  $r=.615$ ,  $p=0.01$ . This result supports the idea that one's personal and political ideologies may indicate a strong relationship with social advocacy and participation.

## 7. DISCUSSIONS

### 7.1 Summary and Conclusions

The results show a high level of respondent nationalism, especially when it came to their general view of the Philippines and its citizens, based on their feeling of national pride. It also shows a high level of respondent social advocacy revolving around their awareness of national political matters. The researchers have then discovered that the two variables are directly correlated to each other. High levels of nationalism amongst the respondents also corresponded to high levels of social advocacy.

In the presence of previous correlational studies conducted regarding the relationship of nationalism with other social ideologies, it is surprising that this study may become another indicator that nationalism has a relevant impact on human behavior, especially regarding national purpose (Seton-Watson, 2019). In line with this, the results suggest that nationalism may be an essential factor in the conduct of Generation Z.

Similarly, high levels of social advocacy amongst the respondents may relate to building one's social identity, as Barnhardt, Sheets, and Pasquesi (2015) explained. This idea may support how the respondents exhibited social advocacy through awareness of political issues as university students. The results suggest that because levels of social advocacy are high, the respondents may be actively engaged in civic movements relating to social justice.

The suggested significant relationship between the levels of nationalism and levels of social advocacy amongst the respondents can be supported by a research study by Ahmad, Alvi, & Ittefaq (2019). The study suggests that an individual's

feelings towards a country and its citizens may be associated with their civic engagement or social advocacy level.

The data analysis and results of the statistical test show similar results from the scales for nationalism and social advocacy, respectively. Hence, the researchers have rejected the null hypothesis and accepted the alternative hypothesis, indicating a significant relationship between the respondents' level of nationalism and social advocacy.

Considering that there may be a significant relationship between the variables and the respondents have expressed high levels for both, this may indicate that Generation Z university students in Metro Manila are nationalistic beings that are civically engaged in social advocacies.

### 7.2 Limitations and Recommendations

A notable limitation of this research would be the chosen sample given the inclusion criteria. This research was limited to only those taking up a Humanities and Social Sciences (HUMSS) related course for university, resulting in a total of only 35 respondents. The researchers acknowledge the lack of generalizability given this criterion and the two-month duration of the research; however, the researchers believe that it remains valid due to related research for the necessary assumptions taken and the results presented.

For those who wish to pursue this topic and extend the research regarding this, the researchers would recommend exploring these variables, including an increased range of college courses. This recommendation may broaden the scope of the research as well as the sample size. In addition to this, the researchers would recommend exploring the relationship of either variable with political activism, considering the observed similarity among the survey questions.

## 8. ACKNOWLEDGMENTS

This research paper's creation process was a journey towards further understanding nationalism and social advocacy amongst Generation Z university students. The researchers wish to extend their utmost gratitude towards everyone who has made this study possible.

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All for Jesus, in Jesus. Embrace new life, be a gift to others!

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## A Comparative Study on the Effects of Size and Sources or Traceability on the Price of Identified Fish Species Sold at Muñoz Market, Quezon City

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**Abstract:** The diversity of fish in markets is constantly dynamic under several factors. The study aims to find the correlation of these factors and their effects with the selection of fishes found in Muñoz Market. This study adopted the research design of the two previous studies to ensure consistency in assessing the gathered data. The researchers utilized premade questionnaires that were given to the vendors working inside Muñoz Market. In analyzing the data, the researchers applied Pearson's correlation coefficient to assess the factors' correlation between them. The results showed an increase in the number of identified species and the price and size range of the fish placed in the market. This implies that the domain of the market is constantly increasing. The market is more diverse than in the past, where new species are introduced to the market and made accessible to the general public at Muñoz Market.

**Key Words:** fish diversity; aquaculture; marine biodiversity; Muñoz Market; Philippines

### 1. INTRODUCTION

Fish are a significant component in consuming a regular Filipino's diet, being highly associated with a reduced risk of coronary diseases due to their high protein and omega-3 fatty acid content (Soluta, 2021). Because of the versatility of fish, namely its accessibility, nutrition value, and affordability, Filipinos all around the islands include fish in their list of provisions and daily diet. Fish do not only play a vital role in the consumption of Filipinos and hold a significant contribution to the country's livelihood in terms of being an occupation (BFAR, 2020). The marketplace is an environment where these two elements collide. A majority of fish that Filipinos allocate for consumption are bought in markets or wet markets. In light of this, one would speculate the factors that affect the diversity of fish that make it into the actual market.

This paper is a third-iteration study concerning the diversity of fish, specifically in Muñoz Market, Quezon City. The first being a study by Arcangel, Caleja, Ignao, and Orejudos in 2019, the second being a study by Valenzuela, Veluz, Villanueva, and Villarama in 2020, and this study in 2021. Both studies being equally comprehensive, distinct, and well-advised, the conclusions and analyses of both papers provided well-rounded and intricate insights on said topic. However, the observations collected by both papers are not constant.

The state in which the fish markets and wet markets are constantly changing due to external

factors such as climate, the economic state, the financial state of the consumers, the location, the season, and several others (Santos, Barut, & Bayate, 2017). There are natural, uncontrollable factors that contribute to the changing markets. However, some factors can be managed, such as the administration of the fishermen here in the Philippines. Given that fishers play a significant role in the economy, the issue concerning the security of the fishermen with the government is at large. Fishers are not given the due amount of care or protection when it comes to their welfare. Studying the trends and parameters inside the markets allows the monitoring of the effects of said disputes. It can inform the authorities about what is critical to protect the Filipinos' rights and the economy and help improve its state as of now.

This study aims to not only determine what factors cause direct or indirect changes to the variety of fish available in the Muñoz wet market but also analyze the trends and parameters of the fish within Muñoz Market with the past two studies by deriving patterns and trends in the fish's attributes and traceability.

The specific objectives of the study are as follows:

- a.) Determine what factors cause direct or indirect changes to the diversity of fish available in the Muñoz wet market.
- b.) Examine the parameters of the fish within Muñoz Market in comparison to the past two

studies by deriving patterns and trends in the fish's qualities and traceability.

## 2. METHODOLOGY

The primary source of data for this study were the stakeholders and fish vendors of Muñoz Market, located in Muñoz, Quezon City. An overview and a street perspective of Muñoz Market can be found in Figures 1 and 2, respectively.



Figure 1. Overview of Muñoz Market



Figure 2. Street view of Muñoz Market

### 2.1. Research Design

This research followed a quantitative design to gather numerical data from the aquaculture, specifically fishes, observed in Muñoz Market. The data was collected through a series of surveys where the respondents were required to fill in the size (mm), price (pHp/Kg), and source (location) of the fish. The data collection of this study was conducted from December 2020 - February 2021, or 13 weeks.

Shown in Figure 3 are the factors considered in obtaining the results for the correlation and comparison study of the fish diversity in Muñoz Market.

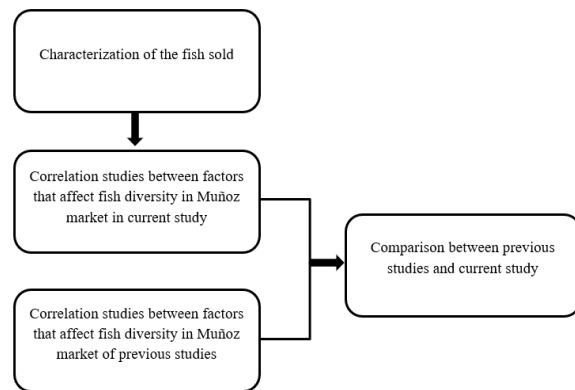


Figure 3. Theoretical Framework

### 2.2. Data Analysis

The results were tabulated utilizing Microsoft Excel, organized according to the code given in the survey form, which includes the length, price, and the source.

#### 2.2.1. Analysis of Present Results

The initial observations from the data collected were summarized to provide an overview of the fishes included in the correlational studies.

#### 2.2.2. Comparison of the Present Results with the Previous Studies

This study compared its findings with the two previous studies to see any consistent trends or notable differences.

#### 2.2.3 Correlation Study

The researchers performed a correlational study between the size and source and its effects on the price of the fish to assess their relationship with each other individually. The correlation between the factors above was evaluated using Pearson's correlation coefficient (Equation 1). This was used in this study to ensure consistency in assessing parameters in line with the two previous studies.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Where n is the number of paired values,  $\sum xy$  is the sum of the products of paired values,  $\sum x$  is the sum per family,  $\sum y$  is the sum per family,  $\sum x^2$  is the sum of squared x values,  $\sum y^2$  is the sum of squared y values.

The parameters that were correlated include (a) the average price and source per family, (b) the average price and source per species, (c) the average

size and average price per family, and (d) the average size and average price per species.

### 3. RESULTS AND DISCUSSION

Discussed in this section are the obtained results and observations from the 13-week data collection period. This segment includes the comparison with previous results, the analysis of the current developments, and the correlational studies between the factors.

#### 3.1. Analysis of Present Results

This section discusses the present results regarding the species, their respective sizes, prices, and sources. There were 74 individual species identified which were classified into 29 different families. The prices ranged from Php 90- Php 1200. The length of the observed fishes ranges from 40-890mm, and their average lengths per family are shown in Figure 4. The family Belontiidae showed to have the highest value length among all families, averaging at 880.87mm.

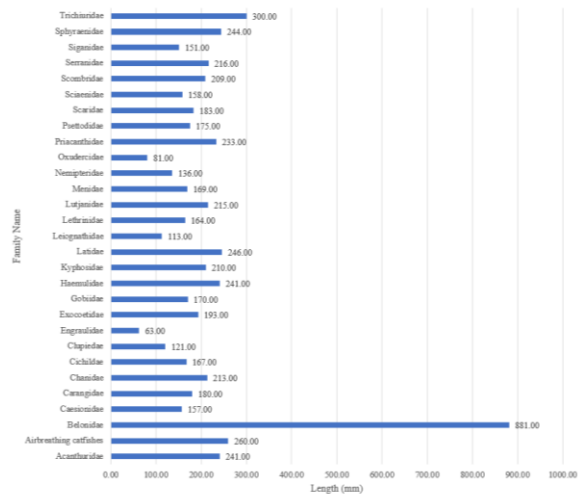


Figure 4. Average Length of Fishes per Family

There were seven sources of fishes identified, namely Lucena, Quezon, Farmers Quezon City, Malabon, Navotas, Batangas, and Dagupan. The primary source in this study is Lucena, totaling to 39% of the observed fishes. A visual representation of the sources can be found in Figure 5.

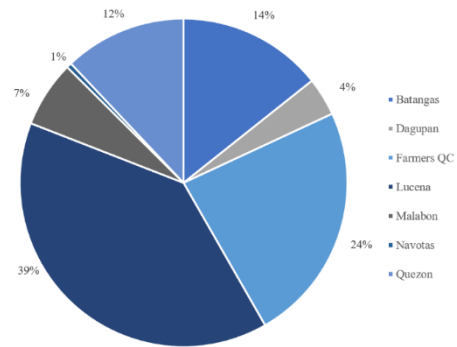


Figure 5. Sources of Fishes

#### 3.2. Comparison of the Present Results with the Previous Studies

Presented in Table 1 is the summary of results in comparison with the two past iterations of this study.

Parameters	Arcangel, Caleha, Ignao, & Orejudos (2019)	Valenzuela, Veluz, Villanueva & Villarama (2020)	Current Study
No. of identified Species	59	66	74
Price range (Php/kg)	90-443.32	80-500	90-1200
Size range (mm)	63-565	25-563	40-890
No. of sources	7	8	7
Period of the Study	Nov 2018- Feb 2019	Sept 2019 - Jan 2020	Dec 2020 - Feb 2021

Table 1. Comparison of results between this study and previous iterations

There was an observed increase in the number of species identified, which were classified into 29 families. There was an increase in both the number of identified species and the price range and size range of the fish placed in the market. This implies that the domain of the market is constantly expanding, where the diversity of species found in the market is becoming more and more accessible to the general public.

A possible reason behind this is the effects of the nationwide quarantine for COVID-19. Since the entire population, fishers included were prohibited from carrying on their usual fishing activities in places like Malabon, Lucena, and Batangas. The



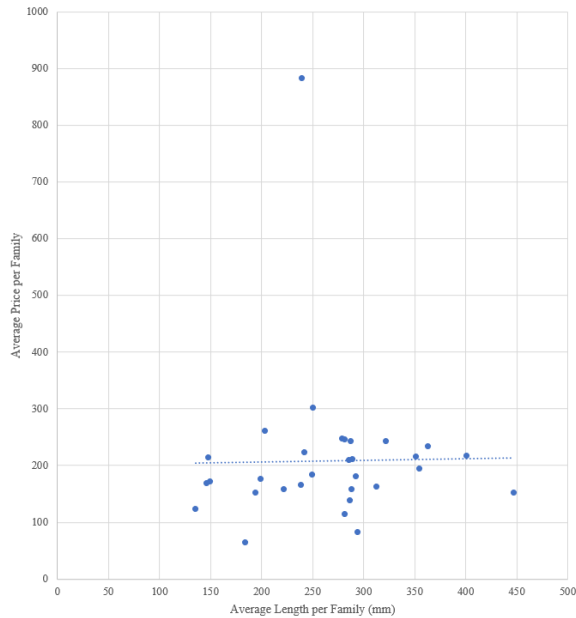
aquatic habitats were able to replenish themselves in terms of population. The prohibition in accessing these former fishing spots may also have contributed to the environmental rehabilitation of said habitats (Ocean Conservation Trust, 2020); thus, the fish could grow stronger, as observed in their increased lengths.

### 3.3. Correlation Study

For the correlation studies, the data was initially organized according to the families they fall under. After this data set was run through the correlation analysis, the figures were re-organized by their respective species and were once again run through the correlation studies.

#### 3.3.1 Price by Length of Fish

As organized by family, the correlation study showed a coefficient of 0.0152 or a negligible correlation, as illustrated in Figure 6, where the graph is almost parallel to the x-axis. But, when re-organized according to their respective species, 12 species showed a high to very high positive correlation between the length and price of fish sold in the market, as seen in Table 2.



**Figure 6.** Effect of Average Length on Average Price Per Family

**Table 2.** Effect of Length on Price of Fish per Species

Species	Pearson's Correlation Coefficient	Interpretation
<i>Nibea soldado</i>	0.9981	Very high positive correlation
<i>Pomadasys argenteus</i>	0.9631	Very high positive correlation
<i>Pomadasys kaakan</i>	0.8267	High positive correlation
<i>Pterocaesio digramma</i>	0.9918	Very high positive correlation
<i>Stolephorus waitei</i>	0.9304	Very high positive correlation
<i>Priacanthus hamrur</i>	0.7917	High positive correlation
<i>Plectropomus leopardus</i>	0.7569	High positive correlation
<i>Selar crumenophthalmus</i>	0.9516	Very high positive correlation
<i>Lutjanus madras</i>	0.7321	High positive correlation
<i>Upeneus moluccensis</i>	0.9859	Very high positive correlation
<i>Sphyræna obtusata</i>	0.8042	High positive correlation
<i>Katsuwonus pelamis</i>	0.8041	High positive correlation

#### 3.3.2. Price by Source of Fish

According to their respective families, the species under the families *Engraulidae*, *Priacanthidae*, and *Serranidae* showed a very high positive correlation, as shown in Table 3. This was interpreted as the source being a factor in the quality of the fish sold, which implies a higher price.

**Table 3.** Effect of Source on Average Price of Fish by Family

Family	Pearson's Correlation Coefficient	Interpretation
Engraulidae	0.9112	Very high positive correlation
Priacanthidae	0.9966	Very high positive correlation
Serranidae	0.9113	Very high positive correlation



Logistically, it is more efficient to source aquaculture from closer sources, such as Navotas or Malabon, both in Metro Manila. However, the quality of water found in these places is questionable. According to Santos et al. (2017), the presence of nitrates (N-NO<sub>3</sub>) in the waters of Manila Bay exceeds the critical value dictated by ASEAN, which creates conditions that make it difficult for fish to live in. Likewise, this determines the degree of pollution in the area. In comparison, the water pollution levels of Metro Manila are at 83.56%, while that of Lucena is at 70.45% (Numbeo, 2021), making the aquaculture from Lucena safer and more fit for consumption. As per individual species, only *Priacanthus hamrur* showed a significant correlation value of 0.9966. This is because the species was sourced from three different locations but being the most expensive when sourced from Lucena.

### 3.3.3. Price Progression of Fish

Three representative species from each price range were included in the comparison so that all three price ranges would be constituted.

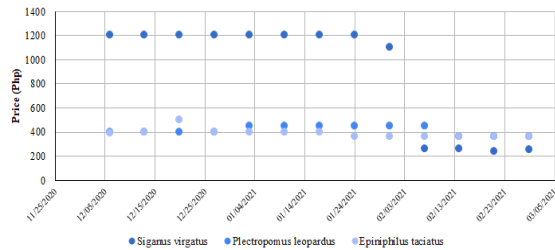


Figure 7. Price progression of three most expensive Species

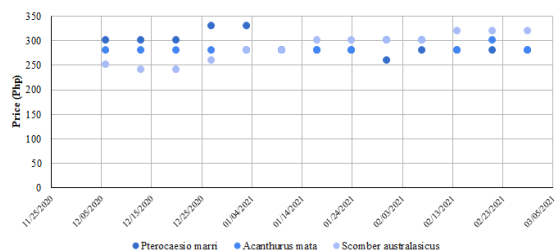


Figure 8. Price progression of three Mid-Range Species

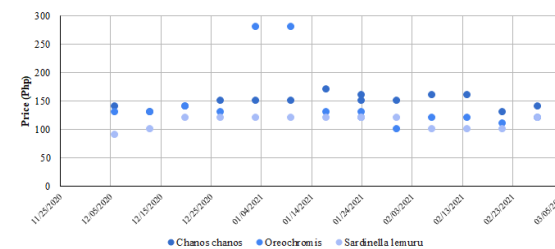


Figure 9. Price progression of three Least Expensive Species

The prices were at a steady constant in the more expensive range, except for *Siganus virgatus*, which experienced a steep drop, as seen in Figure 7. On the other hand, the mid-range priced species in Figure 8 showed a steady but significant increase in price, similar to those in the lower price range, as seen in Figure 9.

Despite the increase in species observed in the market, the prices are still steady despite the predicted decrease due to the supply-demand relationship. The cause of increased costs is the escalating difficulty in providing these quantities due to the rapid degradation of our aquatic ecosystems. According to Abreo (2018), the Pasig River alone contributes 3.21 x 10<sup>4</sup> tons of plastic per year, and the interaction between marine biodiversity and this waste is inevitable. The proportion between habitable water and plastic waste is critical to the ecosystems where our fishermen are supposed to source their livelihood and is detrimental to both.

## 4. CONCLUSION AND RECOMMENDATIONS

In today's world, the rise of carbon emissions, waste products, and the like continue to threaten the sustainability and quality of the marine ecosystem, as observed in the results of this study. The market is more diverse than in the past; new species have been identified and successfully farmed. However, cross-regional transportation still poses a threat to the efficiency of the market, which in turn affects the processes of the economy. Since the aquacultural aspect of the biosphere is subject to change every day, monitoring the fish once per week may not be sufficient. To improve the research in possible future continuations, the researchers think that it is best to conduct the monitoring of the sector more frequently. In addition to this, the researchers believe that observing them in a laboratory to assess their overall health and condition will add a more in-depth assessment of the quality of fish in the study.

## 5. ACKNOWLEDGMENTS

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## Potential Use of Morphological Characteristics in Evaluating Natural Variation of “Barako” Seedlings

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**Abstract:** The Philippines is one of only three countries able to produce *Coffea liberica* and grow two other species of coffee, *Coffea canephora*, *Coffea arabica*. *Coffea liberica*, or “Barako,” is the least cultivated of coffee species. Its unique taste has high potential to grow in the market if production was increased. However, the 2020 Taal Volcano eruption resulted in thousands of damaged Barako trees in 2020 and 2021. As new seedlings are produced, the question of variety among planting material comes up. Farmers need a method to evaluate natural differences of current Barako trees, to answer whether seedlings from farms cultivating Barako are naturally different. This research aims to determine if the morphological characteristics of cultivated seedlings from different farms can be classified through image and statistical analysis. Basic knowledge on how varieties—which produce different flavors, aroma, and market value of coffee—differ among farms is needed for a strategy to increase the number of seedlings. This study’s initial data set indicated statistically significant differences in the average seedling height per node and the leaf area per length of 31, 10-month old coffee seedlings from two different farms, grown in a common environment. The process may be developed further for use in evaluating natural variation among *C. liberica* as seedlings.

**Key Words:** coffee; barako seedlings; *Coffea liberica*; data analysis; morphological characteristics.

### 1. INTRODUCTION

*Coffea liberica*, commonly known as “Barako” coffee, is a species of coffee plant under the Rubiaceae family made known by William Hiern in 1876. *C. liberica* only accounts for about 1% of the Philippine’s coffee production, with *Coffea canephora* as the largest (Philippine Statistics Authority, 2019). Farmers replace their Barako with Robusta and short, hybrid coffee trees because of the surge in demand for instant coffee. With this problem, Barako has been facing difficulties finding its way onto the menus of mainstream coffee (Kapeng Barako, 2018).

The Philippines has a competitive advantage in the global production of *Coffea liberica*, being one of three countries—besides Ethiopia and Malaysia—that can produce *Coffea liberica* (Barako). *C. liberica* accounts for about 3-4% of overall coffee production in the world (Wallengren, 2018). With the current growing market for specialty coffee, *C. liberica* is finding new markets. The species, however, is on the verge of extinction, given very few farms exist. The Taal eruption during early 2020 in Batangas, a province famous for its production of Barako coffee, has further diminished the supply of Barako.

The value of coffee is dependent on its qualities. Variation in harvest quality results in price fluctuations where certain species are sold at higher or lower market prices. The same is true in many different plants, one of which is mangoes (Department of Agriculture, 2019). Certain varieties of mango are sold at higher prices. Farmers, sellers, and buyers base prices on morphological characters that distinguish types and product qualities. For coffee, the market of coffee beans and coffee seedlings is determined in the same way. Phenotypic characters of morphology and quality distinguish varieties grown in different areas. There are more long-term benefits for farmers and plant breeders to use physical characteristics because these are more practical (Kordrostami & Rahimi, 2015). Differences like seedlings (i.e., species, variety, or stock) may equate to differences in other qualities such as tastes, aroma, etc.

Since the Barako coffee has been in demand in the coffee market, the effort to increase seedlings of Barako production will benefit from information on knowing natural differences in Barako stocks. If farmers cultivate different stocks, it would make sense to tag each differently and see if there are corresponding differences in taste, disease



resistance, yield, etc. Hence, being able to differentiate the species of Barako based on the morphology of seedling and leaf characters would be necessary. The gold standard for this would be an analysis of genetic markers, but this would not be feasible for farmers. The process requires much training, equipment, and time, which are not necessarily available to farmers (Rahman et al., 2009).%

Image analysis programs and statistical tools were used to figure out morphological clusters formed from the data gathered. ImageJ is an image processing program capable of calculating area and pixel values of user-defined selections—measuring distances and angles (Bankhead, 2014). It can quantify or measure the plant’s visible traits, such as leaf morphology, to detect the link between its genome and its physiological characteristics (Kokorian et al., 2010). The study used 41 *Coffea liberica* (Barako) seedlings to undergo image analysis to differentiate its morphological characteristics, obtained from two farms grown in a controlled environment. This study was done with the approval of the research faculty responsible for the Senior High School students of DLSU. DNA markers were not used to verify whether the Barako seedlings are of different varieties.

The study can be of great help in assisting farmers, sellers, buyers of coffee in quickly determining *Coffea liberica* varieties. This can help in strategies to increase production of Barako, and hopefully the income as well of those involved in the industry; to encourage them to produce and preserve Barako. Doing so can prevent its decrease, meet the demand for new flavors in the coffee market, and improve the qualities of *C. liberica* varieties in the future.

## 2. METHODOLOGY

### 2.1. Sample Collection

A total of 41 ten-month-old *C. liberica* seedlings from 2 farms in Sarawak, Malaysia, were used as data for the morphological characteristics—31 for leaf area per leaf length and 41 for seedling height per seedling node. They were grown together in a controlled environment.

### 2.2 Data Collection

A camera was used to take images of these seedlings with a meter stick beside them to gather the height and number of nodes (Figure 2.2.1). Four to five leaves were collected by taking images in a parallel manner (Figure 2.2.2). The previously gathered 41 seedlings were named and segregated by category. Data collected from the coffee seedlings

and their leaves are added to Microsoft Excel for data analysis and graphs.



Figure 2.2.1 Seedling with the measuring stick



Figure 2.2.2 Sample Leaf with Ruler

## 2.3. Data Analysis

### 2.3.1. Mean and Standard Deviation

The mean was taken from the raw data of the four main characteristics in the seedlings to see the overall view of the seedlings in groups “Farm 1” and “Farm 2” and as a whole, “All Samples.” Standard deviation was also used to determine the closeness of the variables. A higher value for the standard deviation tells that the data is more spread out, while a smaller standard deviation tells the proximity of the data.

### 2.3.2. Histogram

The histogram was used to determine if two groups can be observed based on the standardized value of the morphological characteristics of the seedlings. If the type of histogram will be skewed to the left or skewed to the right, the data has a high correlation, and that the two groups are possibly



overlapping each other. If it is bimodal, it shows that there are indeed two groups due to a low correlation.

### 2.3.3. Scatterplot

The morphological characteristics of the seedlings and their respective leaves were compared in scatter plots to determine their correlation between each other. The correlation identifies if two groups exist and if these variables are applicable in the differentiation of morphology in *Coffea liberica* seedlings. High correlation is present if the data points are clustered together and have a large R<sup>2</sup> value. Low correlation within scatter plots is present if data points are scattered in a broader range, where it is possible to view two groups within the plot area. Indicated trendline acts as a divider to check for the visible possibility of two groups between the data points, along with the cluster of the data. Standardized values are not found in the scatter plots.

### 2.3.4. Paired T-Test

A Paired t-test was applied to determine whether there is a significant difference between the variability of the two farms based on the standardized values of Seedling Height per Seedling Node and Leaf Area per Leaf Length. When the T-test value is greater than the value from the distribution table, then the null hypothesis that the paired population is equal is rejected; if otherwise, accepted.

## 3. RESULTS AND DISCUSSIONS

### 3.1. Table of Means

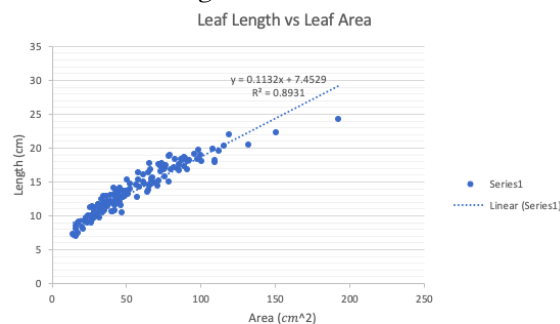
The standardized values for both parameters, seedling height per nodes and area per length, shows that the means from Farm 1 is less than the mean for all the samples, while the means from Farm 2 is greater than the means for all samples. The table below (Table 3.1.1) showed that the mean for the seedlings in Farm 2 is taller than Farm 1. The values of the standard deviation of Farm 2 are more significant in most characteristics, except for the number of nodes and height per number of nodes. Higher standard deviation results in a more considerable variation of values, making it harder to differentiate due to a broader range of values.

**Table 3.1.1** Table of Means

	Farm 1		Farm 2		All	
	Mean	SD	Mean	SD	Mean	SD
<b>Height (cm)</b>	19.2	5.4	26.9	8.03	21.5	8.7
<b>No. of Nodes</b>	5.8	1.4	6.3	1.2	5.9	1.4
<b>Length (cm)</b>	12.3	2.9	14.7	3.5	13.6	3.5
<b>Area (cm<sup>2</sup>)</b>	43.8	20.7	63.1	31.7	54.7	29.1
<b>Height per No. of Nodes</b>	3.2	1.05	4.5	1.02	3.8	1.8
<b>Area per Length (cm)</b>	3.5	0.9	4.2	1.1	3.8	1.1

## 3.2 Scatter Plot

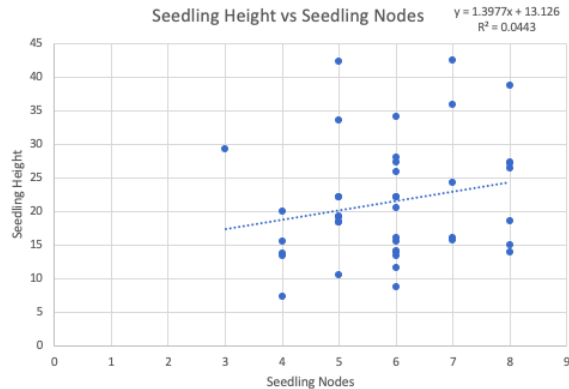
### 3.2.1. Leaf Length vs. Leaf Area



**Figure 3.2.1.1** Scatter Plot of Leaf Length vs. Leaf Area

The graph (Figure 3.2.1.1.) shows a cluster with a high R<sup>2</sup> value of 0.8931, which indicates a high correlation. Due to this indication, these data sets cannot be used separately and must be standardized into “Leaf Area per Leaf Length.” While it is possible to use one, standardization is recommended due to the high correlation. Leaf length was used to standardize leaf area.

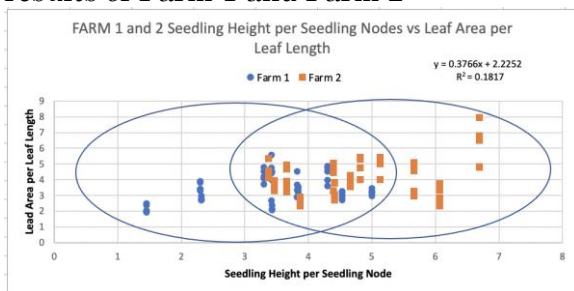
### 3.2.2. Seedling Height vs. Seedling Nodes



**Figure 3.2.2.1** Scatter Plot of Seedling Height vs. Seedling Nodes

Data points (Figure 3.2.2.1.) between seedling height (y) and the number of nodes (x) present a wider spread of plot area covered, with less cluster between points. This low correlation is also shown with a smaller  $R^2$  value of 0.0396, indicating that these variables have very high variability in the data. The separation gives them a significant variation, and it is difficult to compare the sets of data unless they are standardized into “Seedling Height per Seedling Nodes.” This resolves the wide variation that would otherwise make it challenging to compare height with nodes. It is also possible to use one variable, but the variation makes it difficult to choose. Therefore, a standardized value makes it easier to have both variables for the two groups of *C. liberica*.

### 3.2.3. Comparison of data points from results of Farm 1 and Farm 2



**Figure 3.2.3.1** Comparison of data points from results of Farm 1 and Farm 2

Once the overall variables were standardized and combined, they appear to form two overlapping groups (Figure 3.2.3.1). Some variables from Farm 1 and Farm 2 have merged in the middle of the group (between the range of 3 to 5). Combining all characters measured produces a graph that shows groups. The two groups formed are Farm 1

(blue points) located on the leftmost and Farm 2 (orange points) on the rightmost. They are not enough to completely separate them into varieties. It is possible to investigate further the properties that would make the groups distinct by introducing more seedlings, characters, and farms.

### 3.3 T-test

The ability to determine differences in two groups using all the morphological characteristics measured is further emphasized through the T-test.

#### 3.3.1. Seedling Data for Height per Nodes

**Table 3.3.1.1** T-test data for Seedling Height per Nodes

	Farm 1	Farm 2
Mean (X)	3.1	4.6
Sample size (N)	14	13
Standard deviation (S)	1.4	1.05
Paired T-Test Value for Seedling Height per Nodes	3.0802	

When the seedling height by nodes of 14 seedlings from Farm 1 ( $X_A = 3.1$ ,  $S_A = 1.4$ ) and the data of the other 13 seedlings from Farm 2 ( $X_B = 4.6$ ,  $S_B = 1.05$ ) were compared, the resulting t-test value score was  $t(12) = 2.306$ ,  $p < .05$ . This shows differences between the means, as the p-value or threshold acquired from the t-test table (2.306) is lower than that of the t-test score result (3.0802). Therefore, the null hypothesis stating that there is no significant difference between the two farms is rejected.

#### 3.3.2. Leaf Data for Area per Length

**Table 3.3.2.1** T-test data for Leaf Area per Length

	Farm 1	Farm 2
Mean (X)	3.4	4.1
Sample size (N)	55	63
Standard deviation (S)	0.9	1.09
Paired T-Test Value for Leaf Area per Leaf Length	3.7892	



Comparing the leaf area by length of 55 leaves from 11 seedlings from Farm 1 ( $X_A = 3.4$ ,  $S_A = 0.9$ ) with the data of the other 63 leaves coming from 13 seedlings of Farm 2 ( $X_B = 4.1$ ,  $S_B = 1.09$ ); the calculated t-test value score was  $t(54) = 3.7892$ ,  $p < .05$ , indicating significant differences between the means. As the p-value or threshold acquired from the t-test table (2.0154) is lower than that of the t-test score result (3.7892), the null hypothesis that there is no significant difference between the two farms is rejected.

#### 4. CONCLUSION AND RECOMMENDATION

The four parameters: seedling height, seedling nodes, leaf length, and leaf area, are best used as standardized values since it partially separates the groups. These then qualify as characteristics needed to carry out a paired t-test calculation—a statistical analysis done to determine differences between two variables of the same subject. After the seedling samples were classified into two groups, there was a significant difference between them; as two overlapping groups formed from the scatter plot (Figure 3.2.3.1). Thus, these indicate a potential of differentiation by using standardized morphological characteristics of seedlings grown in a controlled environment.

For future studies, it is recommended to get more seedling samples to test and gather more data to distinguish seedlings from various farms. Adding more morphological characteristics to separate further the groups, such as leaf apex, leaf margin, leaf venation, phyllotaxy, etc, is highly recommended. As suggested by the DLSU SHS Research Congress committee (personal communication, 2021; Nakano, as cited in KPU Pressbooks, 2020), morphological identification can also use flowers since it is said to be the part less affected by growth conditions. A larger population and other coffee seedlings will perhaps allow larger variation between *C. liberica* seedlings. Other farms can also be included, and their seedlings can be tested for variation or differentiation of their morphological characteristics, both with the existing parameters and additional ones.

#### 5. ACKNOWLEDGMENTS

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## A Systematic Review on Biosorption of Copper (II) ions in using Water Hyacinth as a Biomass

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**Abstract:** Due to the recent increase in the concentration of heavy metals in urban bodies of waters in the Philippines due to industrialization, the study sought to determine ideal methods of adsorbing these substances and prevent them from posing adverse health effects to surrounding communities. The method in the study reviewed the literature on using water hyacinth biomass as an adsorbent of heavy metals, specifically copper (II) or Cu(II), in contaminated areas susceptible to polluted wastewater runoff. With this, the ideal adsorbent was determined through factors of particle size, initial ion concentration, adsorption time, ideal conditions, and the adsorbent structure. From the reviewed studies, water hyacinth is an effective biosorbent for copper ions and can reduce copper concentrations in wastewater bodies. Ideal factors for maximum adsorption in terms of wastewater characteristics were conclusive amongst the chosen literature. Other parameters, however, require further investigation to determine if there are trends in how they affect adsorption capacity and removal percentage of the biomass.

**Key Words:** adsorption; batch process; biosorption; copper; water hyacinth

### 1. INTRODUCTION

The rise of industrialization has coincided with the increasing presence of heavy metal pollution. This increase occurred rapidly in the latter part of the 20th century in the 1980s and 1990s. A study conducted by Zhou and colleagues (2020) from 1972 to 2017 had determined that sources of the global increase in heavy metal concentration were mining, manufacturing, rock weathering, and agricultural runoff, depending on the region. It was also noted that these increases were more prevalent in developing areas, such as Africa, Asia, and South America, compared to developed regions like Europe and North America.

This development is detrimental to the Philippines as a country heavily reliant on its agricultural and fishery resources. In 2017, Perelonia and colleagues found that heavy metals lead (Pb), cadmium (Cd), and mercury (Hg) had the most notable presence in aquaculture farms and coastal areas in Manila Bay. Although there had been standards set by the Department of Environmental and Natural Resources (DENR) concerning what level of heavy metal presence is considered “safe,” in both the water itself and fish samples, several regions had failed to meet these standards during the country’s dry and wet seasons respectively.

In the past, water hyacinth has been used as an alternative, cost-efficient method of extracting heavy metals, specifically Cu(II). Research conducted by Saraswat and Rai (2010) examined and experimented on the adsorption capacities of water hyacinth to other heavy metals such as Cd, zinc (Zn), and chromium (Cr). Like these elements, Cu(II) has also shown the potential to be adsorbed by the water hyacinth under different conditions.

The study explored the capabilities of water hyacinth as biomass in the adsorption of heavy metals; specifically, Cu(II), an element found in high amounts in industrialized areas, is easily transmitted and poses serious health threats in high doses. It utilized quantitative studies that tested the capabilities of water hyacinth as an adsorbent of Cu(II) under varying conditions, such as the initial concentration of the heavy metal, the particle size of the water hyacinth biomass, and the amount of time which the adsorbent is placed in the heavy metal solution.

### 2. METHODOLOGY

The data from other related studies were compared and analyzed for accuracy in creating an effective water hyacinth adsorbent model. The criteria adapted from the data involved the following factors: initial metal ion concentration, ideal water conditions,

adsorbent structure, adsorbent particle size, and adsorption time. These factors were chosen as they were related to the adsorption process of the water hyacinth and the efficiency in making the ideal model. Following the methods from similar literature, the study focused on a batch procedure for the analysis.

Electronic studies were searched through available databases. The following databases were searched without language, publication year, or publication status restrictions:

- EBSCO Research Databases via the De La Salle University Libraries (Searched March 22, 2021)
- ScienceDirect via the De La Salle University Libraries (Searched March 22, 2021)
- Scopus via the De La Salle University Libraries (Searched March 22, 2021)
- Google Scholar (March 22, 2021)

### 3. RESULTS AND DISCUSSIONS

#### 3.1. Water Hyacinth Biomass as an adsorbent for copper(II) ions

Many biosorption studies involving Cu(II) ions utilized dried and groundwater hyacinth. Grinding the biomass increases the surface area, which results in optimal metal adsorption. Gandhimathi and colleagues (2013) also used the acid treatment on the biomass. All forms of biosorbent showed effective adsorption of Cu(II) ions, the highest removal percentages at 98.8%, 98.19, and 95.1%, as seen in Table 1. (Gandhimathi et al., 2013; Oktaviana Lussa et al., 2020; Sadeek et al., 2015; Singa & Das., 2013).

**Table 1.** Batch Process Adsorption using Water Hyacinth Biomass

Biosorbent Form	Optimal Parameters	Adsorption Capacity	Removal Rate	Reference
Acid-treated	pH 7 10mg/L Cu(II) solution (100 mL) 0.1g/100 mL biomass concentration 300µm - 600µm particle size 75 minute contact time	6.56 mg g <sup>-1</sup>	89.04%	Gandhimathi et al. (2013)
Leaves, Shoots	250 mL Cu-wastewater 10 g biomass Sieved with 100 meshes 1 hour contact time	22.19 mg g <sup>-1</sup>	98.19%	Oktaviana Lussa et al. (2020)
Roots	pH 5 100 mg/L Cu(II) concentration 1 g/100 mL biomass concentration 300µm - 600µm particle size 30°C 20 minute contact time	32.51 mg g <sup>-1</sup>	80%	Li et al. (2013)
Roots	pH 5.5±0.5 20 mg biomass 50 mL Cu(II) solution, varying concentrations	22.7 mg g <sup>-1</sup>	>75%	Zheng et al. (2009)

	Biomass cut into segments			
Roots	25 mg/L Cu(II) concentration adsorbent 10 g/L biomass concentration 250-350 µm particle size 5 hour contact time	21.80 mg g <sup>-1</sup>	>95%	Singha & Das (2013)
Whole Biomass	pH 7 10mg/L metal ion solution, 100 mL 0.1g/100 mL biomass 300µm - 600µm particle size 60 minute contact time	0.49 mg g <sup>-1</sup>	65.93%	Gandhimathi et al. (2013)
Whole Biomass	pH 7 0.5-1mm particle size 25°C 4 hour contact time	181.8 mg g <sup>-1</sup>	95.1%	Sadeek et al. (2015)
Whole Biomass	pH 9 0.5-1mm particle size 25°C 3 hour contact time	181.8 mg g <sup>-1</sup>	98.8%	Sadeek et al. (2015)

When exposed to solutions with several metal ions, the biomass also tends to adsorb ions with a higher ionic radius as they have a greater affinity for adsorption binding sites (Saraswat & Rai, 2010). Compared to other biosorbents, water hyacinth achieves a higher removal percentage at lower pH levels and reaches equilibrium at pH 5 (Husoon et al., 2013; Singa & Das, 2013).

#### 3.1.1 Roots versus Aerial Parts for Adsorption

**Table 2.** Accumulation of Cu(II) in Water Hyacinth parts

Heavy Metal Concentration	Concentration in Water Hyacinth (µg g <sup>-1</sup> dry matter)						
	1 mg l <sup>-1</sup>	3 mg l <sup>-1</sup>	5 mg l <sup>-1</sup>	7 mg l <sup>-1</sup>	10 mg l <sup>-1</sup>	50 mg l <sup>-1</sup>	100 mg l <sup>-1</sup>
Aerial Part	57	68	252	1105	700	1525	1900
Roots	1750	2110	2710	2750	2900	2950	2800

Note. Data was retrieved from Soltan and Rashed (2013).

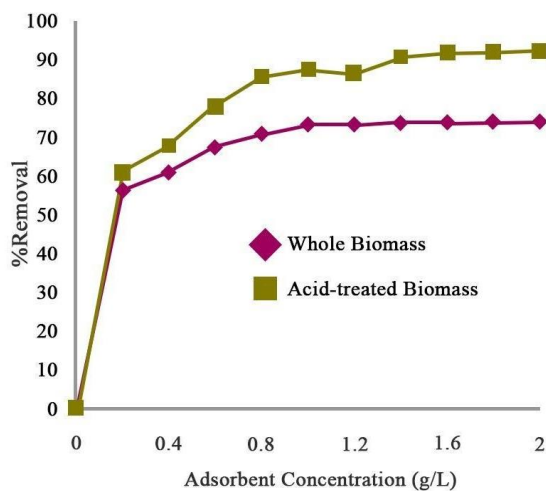
Several studies utilize either roots or aerial parts; however, limited studies compare the adsorption capabilities of different water hyacinth parts under similar conditions. Soltan and Rashed (2003) explored the adsorption capacities of both root and aerial parts in mixed metal solutions containing Cd, Co, Cr, Cu, Mn, Ni, Pb, and Zn at different metal concentrations. They concluded that roots have higher adsorption capacity than aerial parts as seen in Table 2.

#### 3.1.2 Effect of Biomass Concentration on Cu(II) Adsorption

Biomass concentration may also affect the removal rates during metal adsorption. Gandhimathi and colleagues (2013) found that the Cu(II) adsorption percentage increases as the biomass concentration



increases from 0.2 g/L until reaching an optimal concentration of 1.6 g/L with a removal percentage of 74.12% for whole biomass and 92.01% for acid-treated biomass, as seen in Figure 1. Increasing the biomass concentration greater than 1.6 g/L yields almost no increase in removal percentage. This is supported by Oktaviyana Lussa and colleagues (2020), who tested three amounts of biomass (10 g, 15 g, 20 g) for copper adsorption in 250mL wastewater mainly containing Cu(II) ions. Although there were minimal differences in adsorption percentage, as seen in Table 3, these two studies depict a trend wherein increasing the biomass concentration beyond a certain point will negatively affect the resulting adsorption percentage due to interference in the number of active bonding sites of the adsorbent.



**Figure 1.** Effect on Biosorbent concentration on Adsorption Percentage  
 Note. Data retrieved from Gandhimathi et al. (2013).

**Table 3.** Effect of Mass adsorbent on Cu(II) Adsorption

Mass Adsorbent	Adsorption Percentage		
	30 min contact time	60 min contact time	90 min contact time
10 g	97.9626 %	98.1918 %	97.9741 %
15 g	96.7479 %	98.1345 %	97.9282 %
20 g	97.6990 %	98.0886 %	97.9168 %

Note. Data retrieved from Oktaviyana Lussa et al. (2020).

### 3.2 Ideal Wastewater Conditions

From the various studies gathered within the review of related literature, the ideal wastewater conditions revolve primarily around the pH level and initial metal ion concentration. These factors affect the quantity of water hyacinth capable of adsorbing until it reaches the maximum capacity (Saraswat & Rai, 2010). By manipulating how the water hyacinth

attracts and binds to the ions, the ideal wastewater conditions will provide an optimal medium for the adsorption of Cu(II) and the adsorbent. Choosing the most favorable condition for the water hyacinth increases the maximum capacity, contributing to greater adsorption capabilities.

#### 3.2.1 pH Level

The pH level of the wastewater can manipulate the surface charge and the solubility of the adsorbent (Smičiklas et al., 2008). Li et al. (2013) used pH levels 1-7 for Cu(II) adsorption using water hyacinth root powder. Throughout the adsorption process, they observed an optimal pH level of 5; however, pH 6 and 7 also followed a similar yield in adsorption percentage as the optimal pH level. This dependence may be attributed to the accessible hydroxide or carboxylic acid. Zheng et al. (2009) determined that the adsorption of copper (II) through water hyacinth roots with an initial pH of 4.5 was optimal in reaching maximum capacity due to the hydrogen ions that act upon the surface charge of the adsorbent. Additionally, another observation suggested that a decrease in maximum capacity starts after pH goes beyond 5.7. Pisitsak et al. (2019) explained the adsorption efficiency at the pH of 4.63 that was determined through a batch adsorption technique. In another study, Lu et al. (2014) used live water hyacinth plants for copper removal and wastewater maintenance. Due to water loss caused by evaporation, transpiration, and water testing, the pH had to be consistently maintained at a pH of 6 daily by adding 1.0 M HCl and NaOH to produce optimal results. A 2016 study by Zheng et al. tested a lowered pH of 3 and noticed a complete lack of adsorption amount for cadmium and a significant decrease in copper and found a range of  $5.5 \pm 0.05$  to be optimal. The summary of the optimal pH used by the studies is shown in Table 4.

**Table 4.** Optimization of pH Level

Biosorbent Form	Optimal pH Used	Reference
Live Plants	6	Lu et al. (2014)
Plant Fibers	4.63	Pisitsak et al. (2019)
Roots	5.7	Zheng et al. (2009)
Roots	$5.5 \pm 0.05$	Zheng et al. (2016)
Root Powder	5	Li et al. (2013)

The various studies showed that optimizing the pH level can be narrowed down for the adsorption process, with each study presenting an optimal pH range of roughly 4.5 to 5.5. Through experimentation, Li et al. (2013) determined a pH level of 5 as optimal with only minor outliers using 6 and 7. Lu et al. (2014) was an outlier using a pH level of 6, possibly because



of the use of live water hyacinth instead of its biomass forms.

### 3.2.2 Initial Metal Ion Concentration

Saraswat & Rai (2010) mentioned initial metal ion concentration as an essential adsorption parameter because it is dependent on the absorptive surface area of the water hyacinth biomass. In turn, this would affect the saturation of the binding sites if the initial ion concentration were to be increased. This is evident in the study of Singha & Das (2013), which observed that an increase from 5 mg/L to 300mg/L would result in a lower percentage removal, showing a lower concentration would result in the majority of the ions stuck to the binding sites; whereas, a higher concentration would saturate the binding sites and leave excess copper ions in the solution.

A 2008 study by Mishra & Tripathi tested the adsorption capabilities of water hyacinth on five different heavy metals using 100g of live water hyacinth in 10L of water with varying initial ion concentrations. Once again, this study showed that adsorption capacity increases as initial ion concentration decreases. It tested initial copper ion concentrations of 1.0, 2.0, and 5.0 mg/L, resulting in 95%, 89% and 86% adsorption capacities, respectively. Similarly, another study made by Mokhtar et al. (2011) also analyzed the initial ion concentration, the range including 1.5, 2.5, and 5.5 mg/L. Using 250g to 300g of live water hyacinths in 8 L of water with the metal ions, the best result was done with 1.5mg/L with 97.3%, and the worst observed concentration was 5.5mg/L with 61.6%.

### 3.3 Metal Ion Adsorption Process

The experimentation process itself provides several factors that could affect both adsorption percentage and efficiency. These variables are controlled, such as the contact time allowed between the adsorbent and adsorbate. Alternatively, this could also apply to a mechanical filtering process using a filtration column should the study choose to do so.

#### 3.3.1 Contact Time

Contact between the solution and the biomass was often facilitated using incubator shakers at varying speeds and temperatures. While the agitation and its resultant heating of the solution would encourage adsorption, this did not guarantee the highest possible adsorption rate after the solution had reached equilibrium.  $Q_e$  represented this in Table 5, the equilibrium adsorption capacity calculated from a pseudo-second-order kinetic model as this equation was used amongst all the chosen studies.

**Table 5.** *Effect of Agitation and Contact Time on Cu(II) Adsorption*

Rotation Speed	Temperature	Time	Q <sub>e</sub>	Reference
175 rpm	303K	20 min	13.15 ± 0.26	Li et al., (2013)
150 rpm	308K	20 min	24.3	Zheng et al., (2009)
150 rpm	-	5 hr	5.74 (RWH) 9.06 (TWH)	Gandhimathi et al., (2013)

According to the studies conducted by Li et al. (2013) and Zheng et al. (2009), respectively, the maximum adsorption rate was reached within 30 minutes, even peaking after as early as 20 minutes of reaction time. This was contested only by Gandhimathi et al.'s study that used a predetermined reaction time of 5 hours, which resulted in the lowest  $Q_e$  value for both types of water hyacinth used in that particular study (raw and acid-treated).

#### 3.3.2 Filtration Column

Mahamadi and Zambara's (2013) study showcased how mechanical filtration could lead to build-up and exhaustion of the biomass before reaching its total adsorption capacity. This filtration setup used the same amount of adsorbent for bed depths of two different measurements: 6.5 cm and 14 cm. The more tightly packed bed depth of 6.5 cm had allowed for the rapid accumulation of Cu within the filtration setup and the exhaustion of the biomass at around 20 hours. However, using a higher bed depth prevented the premature exhaustion of the adsorbent as it was looser and had made more adsorption sites available.

## 4. CONCLUSION

Water hyacinth is an effective biosorbent for the reduction of copper concentrations in wastewater bodies. Maximizing adsorption capacity and removal percentage in applications requires several factors to be considered. Certain parts of the biomass may result in better outputs. Roots are often preferred over aerial parts; however, limited studies exist comparing the adsorption capacities of parts under the same conditions. The amount of biomass utilized must also be optimized for efficiency as excessive biomass will result in saturation of adsorption sites leading to a limited increase in adsorption and waste of material. Wastewater conditions are also vital. Optimal adsorption results are often produced within pH 4-7, with pH 5 commonly cited as the point of significant increase. Metal ion concentration in the water can also affect removal percentage. Longer contact time during agitation does not garner better adsorption results, thus requiring more studies under the same testing conditions. Alternatively, results while using a filtration column heavily depend on its bed depth. It





recommends loosely packing the biosorbent at a higher bed depth, without much emphasis on the height of the setup itself or how much time was spent in contact with it.

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## Designing a Tensegrity Form of an Outdoor Hydroponic System Utilizing Bamboo (*Bambusoideae*) and Abaca Fiber (*Musa textilis*)

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**Abstract:** The COVID-19 pandemic has caused unemployment and a lack of food. Filipinos have turned to indoor and outdoor gardening as an alternative source of income and food. However, one of the problems faced by home gardeners is space insufficiency. This research aims to find a solution to this problem by designing an outdoor tensegrity hydroponic system and constructing its model using Bamboo (*Bambusoideae*) and Abaca Fiber (*Musa textilis*). The research followed a system called the ADDIE Model to execute its methodology. The dimensions of the tensegrity hydroponic system design were planned during the Analysis phase. Freehand sketches of proposed designs were created during the Design phase. The three chosen proposed designs were rendered using Sketch-up in the Development phase. The best design was picked by comparing the three proposed designs in FreeCAD. The selected design was constructed in the Implementation phase and was evaluated during the Evaluation phase. The chosen design, table-top design, had the highest pascals (Pa) under a Generic Wood stressor in the Von Mises Stress test. The structure maintained its balance and withstood a load of three liters of greywater.

**Key Words:** tensegrity; hydroponic system; bamboo; abaca; COVID-19

### 1. INTRODUCTION

The COVID-19 pandemic is an ongoing crisis that caused a halt in the cycle within the labor market and economic activities. Businesses began to close and were the cause of mass unemployment. Some Filipinos turned to indoor and outdoor gardening as an alternative source of income and food. It has also become an option for farmers to also sell their harvests through e-commerce or online selling (Oxford Business Group, 2020). Gardening is more than just cultivating plants; being exposed to nature creates a feeling of belongingness for those who feel anxious as the COVID-19 crisis becomes more apparent. Space insufficiency for gardening is also a problem of urban housings like apartments (Sofa & Sofa, 2020). An efficient solution for space insufficiency is to use hydroponic systems to occupy small spaces in urban, suburban, and rural residential areas (Grady, 2020). It is composed of stacked layers that promote high crop yield even in smaller sizes. Hydroponic systems can cultivate many plants like herbs and vegetables (Modular Hydro, n.d). With the condition of today's societal needs, growing officinal plants can improve a person's overall health because of the vitamins and minerals it provides (Bri, 2017).

Designing an outdoor hydroponic system while incorporating tensegrity creates a more space-efficient, lightweight, and aesthetic structure in the garden that maximizes space utilization, food

production, and consumption. The components of a tensegrity system are under compression and tension even if they are not touching. This discontinuous appearance creates a floating impression. The strings are at a state of uncertainty within the system, while the bars are at a state of compression, resulting in a balanced and stable structure in space (Arjun, n.d).

Due to the present situation, an actual outdoor tensegrity hydroponic system is limited to a trial-and-error model. The tensegrity hydroponic structure will be composed of indigenous materials: bamboo (*Bambusoideae*) as the bar or compressed materials and abaca (*Musa textilis*) as the tensioned string. The constructed hydroponic system will serve as the experimental model representing how tensegrity appropriately applies in the proposed design. Load capacity and balance will be collected through a simulation in FreeCAD, while design modeling was done on SketchUp. As of the moment, there are no studies applying tensegrity structures to a hydroponic system. In this paper, the researchers aim to achieve the following:

- a. Design a space-efficient and stable tensegrity hydroponic system for outdoor gardening.
- b. Prove that the tensegrity structure is an appropriate alternative structure for the hydroponic system by subjecting it to the Von Mises Stress and load capacity test.
- c. Demonstrate that using indigenous materials such as bamboo and abaca fiber are suitable



substitute materials for the standard hydroponic systems.

## 2. METHODOLOGY

### 2.1 Materials

In constructing the outdoor tensegrity hydroponic system, the primary materials used were bamboo and 3-ply abaca fiber. Three straight PVC pipes (1.4-inch diameter, 4-inch length), six elbow pipes (1.5-inch diameter, 2-inch length), plastic containers, wood glue, and eye hooks were also used.

### 2.2 The ADDIE Model

The researchers integrated a systematic design model involving Analysis, Design, Development, Implementation, and Evaluation (ADDIE). Continuous analyses of the designs' needs and objectives were made for new developments to happen. ADDIE model ensures that the product is deemed effective by the target audience and beneficiaries. Alongside the ADDIE design process is the Human-Centered Design Thinking Process (HCDTP), providing that the proposed design will be relevant and beneficial for a long time (Hoover, 2018).

#### 2.2.1 Analysis and Design

Through the Analysis method, individual and societal needs were determined. Analysis of the outdoor tensegrity hydroponic structure considered the following factors: size, color, shape, and space. Color and ergonomics analysis was done to determine the impression and human comfortability given by the given product.

The Design phase involved daily brainstorming of rapid freehand sketches for a total of one week. The morphology method focused on laying out and organizing the parts involved in the exterior and interior designs of the structure.

#### 2.2.2 Development

The 15 freehand rapid sketches were evaluated and narrowed down into three designs. The three designs were modeled and rendered in SketchUp. The designs underwent experimentation in FreeCAD and the least displaced under stress, and most durable was determined as the final design.

#### 2.2.3 Implementation

This phase included the model construction of the chosen final design in the Development phase. Load capacity was measured by applying varying

liters of water in the basin until a maximum load is reached.

#### 2.2.4 Evaluation

The design's overall aesthetic appearance and tensegrity form were evaluated in balance, space efficiency, and load capacity.

## 3. RESULTS AND DISCUSSIONS

### 3.1 Analysis

The stated factors above were considered while doing the 15 freehand rapid sketches. The researchers made the height of the structure capable of reach with no experience of body discomfort among its users. The structure's color was green to represent peacefulness and nature (Love Nest Design, 2017). Different base shapes were designed to compare sturdiness. A vertical hydroponic system was recommended because it uses smaller spaces compared to those oriented horizontally. Abaca strings on the left and right sides of the structure were aligned to maintain balance.

### 3.2 Design

The main features of the exterior sketches were the top and base platforms. The platforms were designed in regular shapes like a triangle, rectangle, and square, depending on the allocated space at home. Different positions for the bamboo and abaca strings were sketched depending on the base shape. Meanwhile, the main features of the interior sketches were the water pipe placement and water reservoir placement. The bamboos were bored with two to three holes accommodating two to three plants. Containers were placed at the top and bottom platforms for storage and drainage. Figure 1 shows the 15 rapid sketches.



Figure 1. 15 Freehand Rapid Sketches

### 3.3 Development

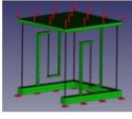
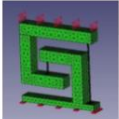
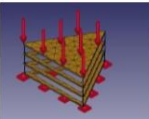
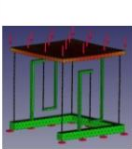
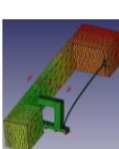
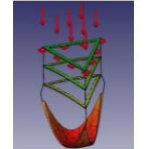


**Figure 2.** Three Chosen Designs Modeled in SketchUp

Figure 2 showed the three chosen designs modeled in SketchUp from the 15 rapid sketches. The three designs were selected because of their aesthetics and capability to store more plants. They were also chosen because they are space-efficient vertical hydroponic systems.

Through the Finite Element Method (FEM) in FreeCAD, the load capacity of the three final designs was calculated. The results in FreeCAD were merely theoretical and only served as a basis for identifying which design is the most durable or most deformed. The Von Mises Stress was used to determine if the chosen material will yield or fracture (Simscale, n.d.).

**Table 1.** Theoretical Results on Stress and Displacement Experienced Gathered from FreeCAD.

	Table-top Design	S Design	Triangular Design
Von Mises Stress Applied By Generic Wood Stressor			
Displacement Caused by Generic Wood Stressor			

In Table 1, the table-top design was the least to experience deformation and maintained its structure when under the Generic Wood stressor. Due to the table-like appearance, the supporting abaca strings at four corners were able to prevent deformity. When the Von Mises Stress from Generic Wood was applied, the table-top design had the highest average load capacity of 1125.04 Pa (refer to Table 2). Higher Pascal (Pa) means that the structure can hold higher pressure or stress. As a result, a table-top design was chosen for scale modeling.

**Table 2.** Theoretical Results on Load Capacity Gathered from FreeCAD

	Table-top Design	S Design	Triangular Design
Average Load Capacity with Generic Wood Stressor (Density: 700.00 kg/m <sup>3</sup> )	1125.04 Pa	81.41 Pa	363.09 Pa

The data about the tensile strength of the bamboo and abaca fiber was gathered from previous studies because a Universal Testing Machine (UTM) was not accessible at the time.

### 3.4 Implementation

Lashing the abaca strings to the bamboo was done to strengthen the model. Green paint was applied to the structure. The size of the model was 19 inches wide, 38 inches long, and 28 inches high. The model's balance was observed to ensure that the concept of tensegrity was applied correctly. The gravity-fed system allowed the water to travel down to the bottom basin and reach the bottom of the punctured disposable cups placed in the holes of the bamboos in the middle. Since the design is relatively open on all four sides, accessing the plants was not a problem. The user must also squat or kneel to access the plants once the hydroponic structure is set down on the ground. A space-efficient hydroponic system was achieved since the knots of the abaca string tied in the eye hooks can be untied if not used and when it occupies small spaces.

### 3.5 Evaluation

The structural form of the final design was assessed by discussing why a specific bar and string positioning was the most space-efficient and durable. Adjustments and revisions were made to improve its structure and functions.



**Figure 3.** The model (perspective) before modifications

The model of the tensegrity hydroponic system was able to balance. The tensioned string at both sides' middle of the two bamboo columns did not snap or break. The four supporting strings at the four edges also did not fracture under pressure even though the top platform was made of wood weighing two kilograms (Figure 3).

A 3-ply abaca string was applied to the model instead of a 5mm and 8mm abaca string because a thinner string can be easily adjusted. Before the modification, the bamboos that were connected to the base of the structure had inaccurate measurements. The elbow pipes inserted on the end of the bamboo were too small and resulted in dripping water on the side of the bamboo. After evaluation, the measurements of the bamboo columns were reduced.

The length of the bamboo columns at the side was decreased by 1.5 inches because the model did not create a floating impression at first. During the second construction phase, all the abaca strings were adjusted appropriately, and duct tapes were no longer needed (Figure 4). The structure was able to withstand pressure without fracture from the bamboo and abaca. It was also required to tie the abaca strings while two or more people equally balanced the structure on its center of gravity. The structure successfully portrayed a floating impression after modifications.



**Figure 4.** *The model (front view) after modifications*



**Figure 5.** *Testing sunlight exposure on the structure*

Figure 5 shows that all hanging bamboo poles are reached by sunlight from 7:30 AM to 11:30 AM. The user can move the structure at any position and direction it faces the sun. The model could withstand an approximate load of three liters of greywater in a basin at the top platform.

Herbs were not cultivated because that has already been proven in multiple designs from other creators. The abaca strings that connect the columns create a pull-push phenomenon while finding its center of gravity wherein the upper part of the compressed column pushes the abaca string down. In contrast, the compressed lower column pulls it, therefore creating tension and balance. The same phenomenon happens at the strings on the four edges of the structure. When the strings on any of the corners are pulled, strings opposite it are stretched, making the structure not fall on one side. Also, if the table is left only with a single string attached to the middle, it will eventually fall in a pendulum motion.

#### 4. CONCLUSION AND RECOMMENDATIONS

The COVID-19 pandemic limited the sources for food and income. Individuals turned to home gardening; however, lack of space was a problem identified. A space-efficient and stable model of an outdoor tensegrity hydroponic system was designed in Sketchup and tested in FreeCAD. The process followed the ADDIE model, which began with rapid sketching that was further narrowed to the final design until it was constructed and evaluated. The Von Mises Stress and load capacity test results proved that the table-top design incorporated with tensegrity is an alternative structure for a hydroponic system. The constructed table-top model used bamboo and abaca fiber and proved its durability under stress and compression.

A recommendation for future research is to use appropriate tools for connecting bamboos so that their sturdiness is maximized. Laboratory equipment such as the UTM should be provided to update tensile strength data. It is also suggested that the hydroponic structure's ideal height should be at least 5 feet high (Reddy, 2018). It is also recommended to use a half-circle hook instead of an eye hook and tie a noose knot rather than a double overhand knot to assemble and disassemble the structure quickly. Replacing the PVC pipes with bamboo water pipes is also advisable. Designing an indoor tensegrity hydroponic system with LED grow lights and a water pump is recommended.

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## Efficiency of Renewable Energy for Reverse Osmosis Desalination Systems in Asian Developing Countries: A Systematic Review

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**Abstract:** Water shortage is an ongoing dilemma, especially in developing countries; hence, various desalination methods are constantly being created. This systematic review aims to assess the efficiency of utilizing renewable energy sources, in terms of operational costs, energy production, and gas emissions, for reverse osmosis desalination systems in developing Asian countries. By screening various texts from the database, ScienceDirect, the researchers found six studies that satisfied the selection criteria. The ROBINS-I tool and the GRADE assessment were used to ensure that the studies were valid for a systematic review. Photovoltaic (PV)-hybrid systems showed the best results in all three categories: operational costs, gas emissions, energy production. This study shows that renewable energy sources for desalination systems are suitable for the environment and found to be the most efficient in all three categories, as seen with PV systems.

**Key Words:** desalination; reverse osmosis; renewable energy; hybrid energy; developing countries

### 1. INTRODUCTION

The continuous reduction of freshwater sources is a “world crisis” (Li et al., 2016). It is even worse for developing countries that lack adequate water facilities, and sewage systems are discharged untreated, which leads to pollution in nearby bodies of water. There are already large-scale desalination and water treatment plants worldwide, with the largest ones in West Asia. Reverse Osmosis (RO) processes, which has a membrane-type desalination process that uses a semipermeable membrane to filter dissolved solids, are deemed relatively less harmful to the environment by producing fewer greenhouse gases and recovering more energy used (“What is reverse osmosis desalination?”, n.d.). Unfortunately, while RO systems create fewer greenhouse gasses than the other alternatives, desalination still emits a hefty amount of CO<sub>2</sub> into the atmosphere due to the utilization of diesel engines to power the plants. Some desalination plants remedy this by using renewable energy sources on their own or in conjunction with non-renewable energy to supply the energy needs of desalination plants. Renewable energy, or clean energy, is taken from natural sources, making them effectively infinite. This study aimed to assess the efficiency of renewable energy sources for reverse osmosis in terms of operational cost, energy production, and gas emissions. Specific energy sources for review are photovoltaic (PVT), wind, and hybrid technologies.

### 2. METHODOLOGY

The efficiency of the desalination systems in question was determined using three means: energy production (in kWh/year), operational cost (in USD), and gas emissions measured in the mass of CO<sub>2</sub> emitted per year.

#### 2.1. Data Sources

To collect data, the researchers used the database ScienceDirect. The following keywords were sought:

("Reverse Osmosis" OR "RO") AND "Country" AND "Desalination"

The inclusion and exclusion criteria were based on an evidence-based model known as the PICO (Problem, Intervention, Comparison, Outcome) approach (“Guides: Evidence-Based Medicine Resource Guide: Clinical Questions, PICO, & Study Designs,” 2020). The researchers used studies from developing countries in Asia regarding Reverse Osmosis and compared the different energy sources used in reverse osmosis systems.

The PICO model used was comprised of:

P: Reverse Osmosis system

I: Renewable energy (PVT, Wind, and Hybrid)

C: Conventional energy (Diesel)

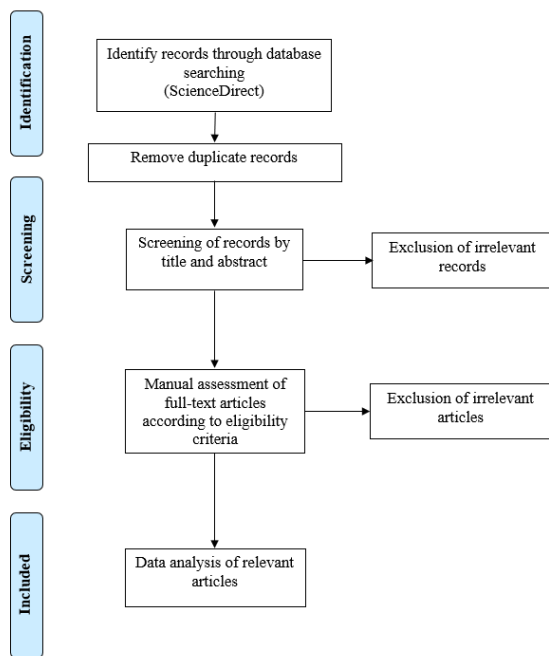
O: operational cost, energy production, and gas emissions

Inclusion Criteria:

- published texts from 2010 to 2020
- legally accessed research articles
- English
- experimental or case study design

## 2.2. Data Collection

The data collection process followed the 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram (Figure 1) in selecting relevant articles for review (Moher et al., 2009). The screening of databases was performed following the selection criteria. The researchers then conducted a manual search of the remaining references by hand-searching and filtering texts according to their title and abstract. The remaining duplicates were also manually removed during this step. Further screening of the remaining papers included the search for the included parameters required for the study.



**Figure 1.** Initial PRISMA Flow Diagram to be utilized in the study

## 2.3 Risk of Bias Assessment

The risk of bias assessment followed the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool (Higgins, et al., 2020). This tool is recommended for assessing the risk of bias in non-randomized studies. Several reporting items were subjected to low, moderate, serious, and critical levels from having the lowest risk of bias to that of the highest. Each reporting item was presented with a signaling question that guided the researchers to

assess the indicating risk of bias for a particular aspect in the methodology.

## 2.4 GRADE Assessment

The data were analyzed and synthesized through the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach used to determine the quality of evidence in a systematic review (GRADE Working Group, 2013). It is a transparent and structured process with specific definitions for each quality of evidence.

## 3. RESULTS AND DISCUSSION

### 3.1 Characteristics of Included Studies

According to the selection criteria, they were collated and characterized according to study methods, system description, interventions, and outcomes, as shown in Table 1. A total of 6 papers were selected for review.

**Table 1** Summary table of the characteristics of individual studies

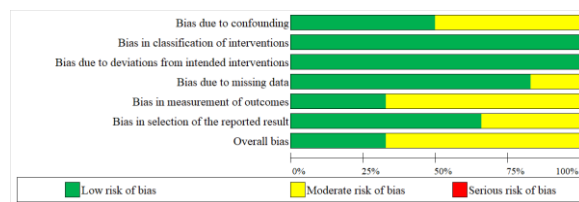
Study	Study Methods and Location	Energy Sources Used (Intervention)	Outcomes	Reference
Atallah et al. (2020)	Case series used HOMER software simulations Location: Nakhli city, Egypt	Diesel PV Wind Turbine Hybrid	Net present cost Monthly average electric production Carbon dioxide emissions Levelized cost of energy (COE)	Atallah, M. O., Farhat, M. A., Lotfy, M. E., & Senjyu, T. (2020). Operation of conventional and unconventional energy sources to drive a reverse osmosis desalination plant in Sinai Peninsula, Egypt. <i>Renewable Energy</i> , 145, 141-152. <a href="https://doi.org/10.1016/j.renene.2019.05.138">https://doi.org/10.1016/j.renene.2019.05.138</a>
Gnaifaid & Ozcan (2020)	Experimental Location: Mersin, Turkey	Solar energy-driven trigeneration plant with thermal energy storage	RO Recovery ratio Solar Panel unit size effect on product cost ORC pressure ratio on electricity cost Ratio of Energy efficiency and cost Effect of global solar radiation on trigeneration costs Effect of RO recovery ratio on RO plant energy efficiency and freshwater cost at various seawater salinity	Gnaifaid, H., & Ozcan, H. (2020). Multi-objective optimization of a concentrated solar energy driven trigeneration plant with thermal energy storage: A case study for Turkey. <i>Case Studies in Thermal Engineering</i> , 20, 100642. <a href="https://doi.org/10.1016/j.csite.2020.100642">https://doi.org/10.1016/j.csite.2020.100642</a>
Gökçek (2018)	Case series Location: Niğde, Turkey	Diesel Wind PV Hybrid	Kgs of pollutant gases emitted per year Operational Cost	Gökçek, M. (2018). Integration of hybrid power (wind-photovoltaic-diesel-battery) and seawater reverse osmosis systems for small-scale desalination applications. <i>Desalination</i> , 435, 210-220. <a href="https://doi.org/10.1016/j.desal.2017.07.006">https://doi.org/10.1016/j.desal.2017.07.006</a>
Ibrahim et al. (2020)	Case series HOMER software simulations Location: Ras El Bar City, Egypt	Diesel Wind Turbine PV Hydrokinetic Hybrid	Monthly average electricity production Levelized cost of electricity Levelized cost of water Pollutant emissions Net present cost	Ibrahim, M. M., Mostafa, N. H., Osman, A. H., & Hesham, A. (2020). Performance analysis of a stand-alone hybrid energy system for desalination unit in Egypt. <i>Energy Conversion and Management</i> , 215, 112941. <a href="https://doi.org/10.1016/j.enconman.2020.112941">https://doi.org/10.1016/j.enconman.2020.112941</a>



Jones et al. (2016)	Case series Location: Jordan Valley, Jordan	PV	Net revenue (\$/ha/year) Annual water requirement (m <sup>3</sup> /ha/year) Area (ha) Water depth (m) Water salinity (ppm) Water temperature (°C)	Jones, M. A., Odeh, I., Haddad, M., Mohammad, A. H., & Qumr, J. C. (2016). Economic analysis of photovoltaic (PV) powered water pumping and desalination without energy storage for agriculture. Desalination, 387, 35-45. <a href="https://doi.org/10.1016/j.desal.2016.02.035">https://doi.org/10.1016/j.desal.2016.02.035</a>
			Total capital cost (US\$) Annual operating cost (US\$) Overall water unit cost (US\$ m <sup>3</sup> ) Net present value Internal rate of return Return on investment	
Qiblawey, Banat, & Al-Nasser (2011)	Experimental Location: Hartha Charitable Society in the northern part of Jordan	PV	Percentage of recovery (%) Salt rejection percentage (%) Specific energy consumption (kWh/m <sup>3</sup> ) Permeate production (L/h) Total dissolved salts (30 mg/L) PV module efficiency (%)	Qiblawey, H., Banat, F., & Al-Nasser, Q. (2011). Performance of reverse osmosis pilot plant powered by Photovoltaic in Jordan. Renewable energy, 36(12), 3452-3460. <a href="https://doi.org/10.1016/j.renene.2011.05.026">https://doi.org/10.1016/j.renene.2011.05.026</a>

### 3.2 Risk of Bias Assessments

The summary of all Risk of Bias assessments (Figure 2) indicates that approximately 33% of all chosen papers possessed a low risk of bias. Four papers have a moderate risk of bias. The moderate risk of bias was due to the modifications of initial interventions, which presented biases. This is conceivably due to the lack of representation in some data sets for selected articles, including those of Atallah et al. (2020), Ibrahim et al. (2020), and Qiblawey, Banat, & Al-Nasser (2011). Bias in the measurement of outcomes was also moderately prevalent because some interventions of renewable energy sources were presented using similar but different results, likely linked to the differing nature of each intervention.



**Figure 2** Percentage of responses in the risk of bias assessments for individual studies using the ROBINS-I tool

### 3.3 Quality of Evidence Assessments

For the quality of evidence assessment, the articles were graded according to the criteria specified in the previous chapter. Some items that may be seen in the paper potentially increased the quality of evidence, while some things decreased the quality of evidence in the paper. Table 2 shows the GRADE

assessments for each paper with the corresponding overall quality of evidence.

**Table 2** Summary of GRADE assessments of individual studies

Study	Initial Quality of Evidence	Factors Increasing Quality of Evidence	Factors Decreasing Quality of Evidence	Overall Quality of Evidence
Atallah et al. (2020)	Low	Large magnitude of an effect (↑1 level) Effect of plausible residual confounding (↑1 level)	Inconsistency of results (↓1 level)	Moderate
Gnaifaid & Ozcan (2020)	Moderate	Large magnitude of an effect (↑1 level)	None	Moderate
Gökçek (2018)	Low	Large magnitude of an effect (↑1 level)	Limitations in study design or execution (risk of bias) (↓1 level)	Moderate
Ibrahim et al. (2020)	Low	Large magnitude of an effect (↑1 level) Effect of plausible residual confounding (↑1 level)	Inconsistency of results (↓1 level)	Moderate
Jones et al. (2016)	Moderate	Large magnitude of effect All plausible confounding would reduce the demonstrated effect or increase the effect if no effect was observed	Limitations in study design or execution (risk of bias) Inconsistency of results	Moderate
Qiblawey, Banat, & Al-Nasser (2011)	Moderate	Large magnitude of effect	Limitations in study design or execution (risk of bias)	Moderate

### 3.4 Discussion

#### 3.4.1 Operational Costs

In terms of operational costs, the desalination system with the lowest costs would be a hybrid PV/diesel with a storage battery system. This trend can be seen in the studies of Atallah et al. (2020), Gökçek (2018), and Ibrahim et al. (2020). Atallah et al. (2020) didn't state the exact costs other than mentioning it having the lowest net present cost. For Gökçek (2018), the net current cost was said to be \$152,672. In the study of Ibrahim et al. (2020), their second option has photovoltaic/ hydrokinetic (PV-HKT) with a diesel generator as their optimal case; in fact, it showed lower costs than their first option's optimal case, which is the hybrid PV/Wind with a diesel generator. The second option showed a net present cost of 60,333 \$, while the first option had a net present cost of 119,260 \$. If implemented in the Philippines, it would be best to follow the trend of desalination systems in Asian developing countries and create a hybrid PV/diesel with a storage battery system.



### 3.4.2 Energy Production

In terms of energy production, the most efficient systems are hybrid PV/Diesel. Multiple cases are examined in related articles conducted by Atallah et al., Gökçek, and Ibrahim et al., concluding that PV systems out of all the other renewable energy sources, such as Wind turbines and diesel systems, perform more excellently for RO desalination systems. Considering that diesel and grid systems produce gas emissions while renewable energy sources such as PV arrays do not, the results presented by PV systems, despite their limited resources, are beyond compatible. Ranging from 8.3 kW to 32.7 kW to produce at maximum, 286,119 kWh per year breeds the best results for PV arrays connected to diesel systems. Diesel systems contribute to about 4.7% of the overall energy used. Based on the related literature, either a 19-string lead-acid battery or a wind turbine was used as the additional source of energy production for PV/Diesel hybrid systems that create the best performing hybrid approach in terms of energy production.

### 3.4.3 Gas Emissions

On the topic of gas emissions, the chosen studies generally saw similar results for similar cases. All desalination systems that make use only of renewable energy see zero emissions without exception. All the studies also come to similar conclusions in that sole diesel-powered desalination plants yield a significantly higher amount of greenhouse gas emissions than renewable energy and renewable-diesel hybrids. While their findings on hybrid energy systems differ, the studies still generally follow the same consensus in that hybrid systems, most notably those that employ HKT, significantly decrease carbon emissions than sole diesel systems with the PV-HKT-Diesel system emitting only 634 kg/year of CO<sub>2</sub>.

## 4. CONCLUSION

The utilization of renewable energy for desalination systems should be encouraged because of its limited effect on the environment and as the most efficient means of creating energy for desalination systems regarding operational cost, gas emissions, and energy production. PV-Hybrid systems saw the most success in all categories in most of the studies. HKT-Hybrid designs, however, found the most success in all types except for energy production but only appeared in Ibrahim et al.'s study, making the results not as reliable nor conclusive as those for the PV-Hybrids. It is recommended that further research in the utilization of HKT hybrids for desalination plants be done. Future research is also essential to identify other factors that contribute to the implementation of

renewable energy for reverse osmosis plants, such as a specific country's geographic profile.

## 5. ACKNOWLEDGMENTS

We would like to thank Ms. Sherilyn Abarra and Ms. Leah Madrazo for their continuous guidance and support during the period of this review. Without their countenance, this study would not have come to fruition. We would also like to gratefully acknowledge De La Salle University for providing access to the resources needed and allowing us the opportunity to conduct this review, especially given the current circumstances of the pandemic.

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<https://doi.org/10.1016/j.renene.2011.05.026>



## The Effect of Mango Peel on the Growth of Okra (*Abelmoschus esculentus*)

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**Abstract:** Fertilizers are substances containing nitrogen, phosphorus, and potassium. They supply nutrients to the soil to improve plant growth and plant productivity. While they may have helped the agriculture sector better their crops, recent studies suggest that common fertilizers adversely affect the environment and human health. Aside from common fertilizers, fruit peels, such as mango peels, also pollute the environment since their accumulation leads to waste disposal issues. To alleviate these issues, researchers proposed the utilization of fruit peels as fertilizers. In this study, mango peels were utilized as fertilizers to identify their effects on the growth of the okra plants by measuring the plant height and comparing the number of leaves. Five (5) pots with two okra seeds were assigned specified amounts of mango peels: 0 g, 1 g, 3 g, 5 g, and 7 g. Plant height and number of leaves were measured every two weeks for two months. The results suggest that varying amounts of applied mango peels affect the growth rate of okra, with 7 g yielding both the highest plant height and highest number of leaves. The results can be attributed to the nutrients of the mango peels, such as potassium and phosphorus, which are included in the three primary nutrients found in common fertilizers.

**Key Words:** mango peels; okra; fertilizer; plant height; number of leaves

### 1. INTRODUCTION

Fertilizers are organic or chemical products that supply the soil nutrients, primarily nitrogen, phosphorus, and potassium, to improve plant growth and plant productivity (Morari et al., 2011; Jariwala & Syed, 2016). For some time, organic fertilizers have been the primary source of nutrients for plants since these have helped the agriculture sector improve their soil and crop growth (Morari et al., 2011).

Despite its benefits for soil management and plant growth, studies have found significant adverse effects on the environment and human health, ranging from water or air pollution, crop contamination to food borne illnesses (Morari et al., 2011). In response, researchers have sought alternative sources of nutrients aside from the common fertilizers, one of them being the utilization of agro-wastes, such as fruit peels. Previous studies by Halpatrao et al. (2019) and Jariwala and Syed (2016) confirmed that fruit peel fertilizers are suitable as soil fertilizers after analyzing the peels' pH level and nutrients.

However, there is still a lack of study regarding the utilization of mango agro-waste as fertilizers. Mangoes are among the most globally advertised fruits, with their global production increasing to 50.65 million metric tons of mangoes in 2017 (Statista, 2020). Their wastes were found to be

abundant in potassium, phosphorus, and calcium, with the first two being part of the three primary nutrients found in common fertilizers, implying the mango peels could potentially be utilized as fertilizers (Nijiru et al., 2014; The Fertilizer Institute, 2016).

This study focused on utilizing mango peels as fertilizer and an alternative to common fertilizers by determining whether it is effective on okra. Okra plants were used since they grow and germinate fast, making them suitable for observing the effects of fertilizer for a short time. Okra takes 6 to 18 days to germinate and 2 to 3 months for it to mature (Luttjohann, 2017; Masabini, n.d.; Seed Savers Exchange, n.d.). During the experiment, medium-sized chopped carabao mango peels were used and introduced onto the soil of the okra plants in specified amounts for each pot. The plant height and number of leaves of the plants were measured and counted, respectively, then evaluated whether varying amounts of mango peels affect the growth of the okra plants. The effects of mango peels and common fertilizers were not compared.

### 2. METHODOLOGY

#### 2.1 Materials

The variant of mango used for the study was the Philippine mango, otherwise known as the



Carabao mango since it is the most produced mango variant in the Philippines (Philippine Statistics Authority, 2021). Next, the five pots used were approximately 12” in height and 12” in diameter. Okra (*Abelmoschus esculentus*) seeds were also used since okra can grow in season all year round (Bureau of Plant Industry, 2020).

### 2.2 Mango Peel Application

Two researchers were assigned to the experiment. Each researcher gathered all the needed materials for the first week: Five pots, okra seeds, and mango peels. Once the materials were complete, two okra seeds were planted in each pot. These seeds were given one to two weeks to germinate before proceeding to the mango peel application.

The researchers were assigned to plant two okra seeds and apply 0 g, 1 g, 3 g, 5 g, and 7 g of mango peels in each pot. The pots were labeled as follows in Table 1. The MPs in the code stand for mango peels, while the numbers stand for the number of mango peels applied in grams.

**Table 1.** Labels for the number of mango peels applied to each pot

Code	Amount of Mango Peels (g)
MP0	0
MP1	1
MP3	3
MP5	5
MP7	7

After the plant germinated, the mango peels were placed onto the soil of each plant according to the amount designated per pot every two weeks until the last data collection. The plant height was measured and recorded in centimeters to observe plant growth. Aside from plant height, the number of leaves attached to the plant was also recorded. The researchers also met every two weeks for two months to discuss and gather all the collected data until the last week of observation. Then, the data were analyzed and compared using various analysis strategies.

### 2.3 Research Design

An experimental type of research was conducted, which allowed the researchers to observe the effect of varying amounts of mango peels on the plant. The setup consisted of five pots, with each having two seeds of okra plants. Each pot was labeled as follows: MP0, MP1, MP3, MP5, and MP7. Furthermore, the researchers had 14 weeks to conduct the experiment, observe the plants, and collect

primary data centered on plant height changes and the number of leaves. After gathering the data every two weeks for two months, the researchers set meetings to analyze the data that they have collected.

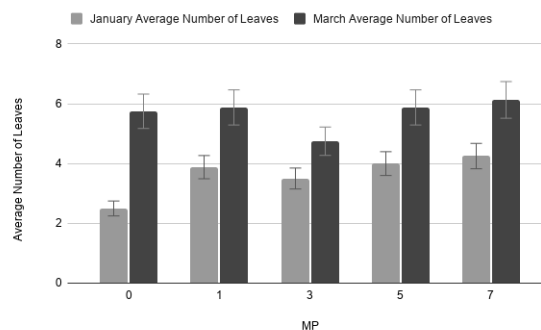
### 2.4 Data Analysis Strategy

First, the researchers observed the effects of the mango peels on plant growth by analyzing and comparing the plant height and number of leaves data per pot. The collected data from the experiment was organized and kept on a log to ensure ease in data classification and data analysis. The plant’s growth was presented on a bar graph to show the differences between the height of the plants each time it was recorded every two weeks for two months. Lastly, error bars were used to identify the uncertainties and the variability of the data gathered.

## 3. RESULTS AND DISCUSSION

### 3.1 Number of Leaves

The number of leaves that were attached to the plant was counted, while those that were unhealthy or wilted but attached were not. The following bar graph shows the recorded average number of leaves per gram from January and March.



**Figure 1** Average Number of Leaves Per MP

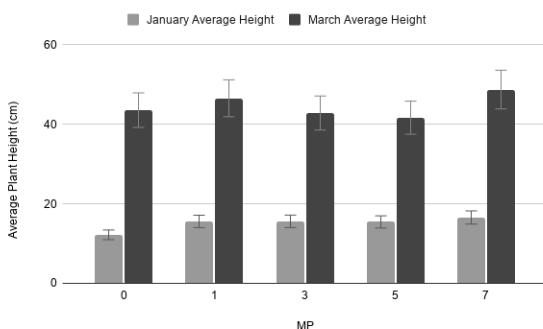
MP7 had the highest average number of leaves for both January and March, which is consistent with the study by Wazir et al. (2018), in which they observed from their research that the fruit peel fertilizer yielded the most significant number of pea leaves, with a mean average of 79.00, as compared to the controlled setup, which had a mean average of 55.00. On the other hand, MP3 yielded the lowest for January while MP3 for March. The results may be associated with the phosphorus and potassium content of mango peels. Both enhance plant growth by improving the photosynthesis rate through an increased adenosine triphosphate production in the plants (Conway et al., 2003; Kirschbaum, 2010; Kaisler & Rosen, 2021). According to the findings of Xu et al. (2020), using fertilizers with high



concentrations of nitrogen, phosphorus, and potassium yields the highest number of leaves per plant as compared to the other fertilizer treatment. This would explain why the setups with the least amount of mango peels applied yielded the least number of leaves since they had less to no added nutrients from the fertilizer to absorb and promote their plant growth. Aside from that, the aphid infestation during the first data gathering in March may have also contributed to the significantly low yield of MP3 in the same month. According to Sorensen (2009), aphids can hinder nutrient absorption by feeding on plant sap.

### 3.2 Plant height

The plant height measurement was used as an indicator of its growth rate. The recorded plant height from each MPs from both the researchers was averaged and plotted into a bar graph to observe the effect of different mango peel concentrations on the growth rate of the okra plants. Below is the bar graph for the average okra plant height with varying amounts of mango peel applied.



**Figure 2.** Average Plant Height Per MP

For both January and March, MP7 had the highest average height while MP0, the controlled variable, had the lowest for January and MP5 for March. For MP5, its short average plant height may have been caused by the aphid infestation that affected one of the MP3 and MP5 setups during the first data gathering in March. According to Sorensen (2009), aphids can remove plant nutrients, which may have caused a decrease in the growth rate of MP5. On the other hand, the high potassium and phosphorus content in mango peels may have contributed to the highest average height of MP7 for January and March (Nijiru et al., 2014; The Fertilizer Institute, 2016). Both potassium and phosphorus enhance the rate of photosynthesis by increasing the production of adenosine triphosphate within the plants, consequently improving their growth rate (Conway et al., 2003; Kirschbaum, 2010; Kaisler & Rosen, 2021).

In addition, the results are also consistent with the findings of Mercy et al. (2014), in which the plant height of the fenugreek with fruit peel power applied to the soil was higher than the one without. Furthermore, Halpatrao et al. (2019) also support the result, as they have found that fruit peels increase the plant height and shoot length of the monggo plant.

## 4. CONCLUSIONS

The study results showed that varying amounts of mango peels affect the growth of the okra and that mango peels can be an effective alternative to common fertilizers for okra plants. In terms of the best amount of mango peel fertilizers to apply, the results suggest that MP7 is the most effective for the growth of the okra, seeing that MP7 was the only setup to yield the highest plant height and number of leaves consistently. The results can be attributed to the nutrients of the mango peels, such as the presence of potassium and phosphorus, which are included in the three primary nutrients of common fertilizers (Nijiru et al., 2014; The Fertilizer Institute, 2016). On the other hand, MP3 was with the lowest plant height and number of leaves, primarily due to the aphids damaging the plants and disrupting nutrient absorption.

Future researchers are recommended to analyze the leaf areas and to test the mango peel fertilizers on other plants for further studies. Additionally, it is also recommended in one specific location so that the results would be precise.

## 5. ACKNOWLEDGMENTS

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## The Design Development of Solar Box Cooker on Wheels as an Alternative for Philippine Rural Households

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**Abstract:** Cooking accounts for a significant share of the worldwide energy consumption issue. Solar box cookers are a good alternative in mitigating fossil fuels and biomass use, especially for tropical developing nations like the Philippines. Still, their broad acceptance is limited by their high dependence on sufficient sunlight for better performance. Thus, this research aims to develop a thermal-efficient, portable solar box cooker with sand-sensible heat storage materials, coconut coir (*Cocos nucifera*) agricultural waste insulators, and locally sourced building materials. The designed and constructed cooker was evaluated using three thermal performance tests: the Stagnation Temperature test from the Bureau of Indian Standards (BIS), the Cooking Power test from the American Societal of Agricultural Engineer (ASAE) Standards, and a rice cooking test. Data obtained from the three-day trials of each test were used to determine the first figure of merit ( $F_1$ ), the single measure of performance ( $Ps(50)$ ), and its ability to cook 300 g of NFA rice with 500 mL of water, respectively. It was found that the cooker achieved an  $F_1$  of 0.06  $Km^2/w$ , a  $Ps(50)$  of 6.651 W, and cooked rice for one-third of the tests. Obtained experimental findings showed that the device is marked as a Grade-B solar cooker. Results indicated that the solar box cooker is capable of pasteurizing water and cooking rice.

**Key Words:** solar box cooker; thermal performance; stagnation temperature; cooking power; rice cooking ability

### 1. INTRODUCTION

With the increase of the human population and industrial developments, energy demand increases due to the high consumption for human endeavors. An essential energy activity in domestic sectors that accounts for 50% of energy consumption is cooking (Aadiwal et al., 2017). This activity makes fossil fuels, such as charcoal, wood, and natural gas, the most dominant energy source broadly used in many households. (World Health Organization, 2016). According to Das et al. (2017), one of the most prominent biomass consumers, including charcoal and fuelwood, in developing countries is rural households. Despite its cost-effectiveness, these energy sources pose higher pollutant emissions and health problems (Yamamoto et al., 2013); thus, necessitating developing alternative, sustainable, and economically feasible cooking methods.

The sun's solar radiation acts as an efficient and eco-friendly energy source for cooking, given it is clean, renewable, abundant in nature, and accessible in various tropical regions worldwide. The Philippines, a tropical country that receives 4.87  $kWh/m^2$ , holds a potential beneficiary for solar technology (Malicdem, 2015). Solar cookers harness solar energy to convert it into heat for cooking food

and pasteurizing water. Among the different solar cookers, a Solar Box Cooker (SBC) is the most suitable type for developing countries, given its simple and durable design, low-cost materials, minor interference, and risk-free features (Kimambo, 2007; Aadiwal, 2017). It takes advantage of direct and diffuse solar radiation in generating heat as the glazing cover traps it inside the cooking chamber.

Despite its ideal structure, it exhibits drawbacks in thermal performance due to its slow cooking process. With the sun's intermittent nature, the device's dependence on consistent solar energy hinders its pervasive use and immense potential. Researchers attempted to resolve this by altering solar box cookers' components to examine whether it could further improve its thermal performance.

Aremu and Akinoso (2013) tested five different solar box cookers. They concluded the cooker insulated with coconut coir (*Cocos nucifera*) was the best performing, for it yielded satisfactory results in stagnation temperature and thermal efficiency (Aremu & Akinoso, 2013). As for sensible heat storage material (SHS), Francis et al. (2016) advised using sand for a higher energy-storing efficiency of 4.145% compared to water. The Philippines produces a considerable number of agricultural wastes, including



coconut coir (*Cocos nucifera*), and uses sand for multiple construction purposes. This study used locally available insulation, sensible heat storage, and construction materials to develop a thermal-efficient solar box cooker as an alternative cooker for Filipino rural households.

The specific objectives of the study are the following:

1. Design and construct a portable solar box cooker with Vibro sand SHS material, coconut coir (*Cocos nucifera*) insulator, and readily available materials in the Philippines; and
2. Evaluate the solar box cooker's thermal performance using three thermal performance tests: the Stagnation Temperature test, Cooking Power test, and a rice cooking test.

## 2. METHODOLOGY

A quantitative research method was adopted to evaluate the designed solar box cooker's thermal performance fabricated using local materials, Vibro sand sensible heat storage material (SHS), and coconut coir (*Cocos nucifera*) insulator. The methodology was divided into three phases: the design and construction phase, the performance testing phase, and the performance evaluation phase.

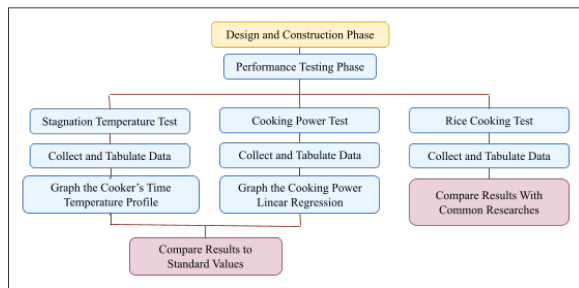


Figure 1 Methodology Flow Diagram

### 2.1 Design and Construction of the Solar Box Cooker

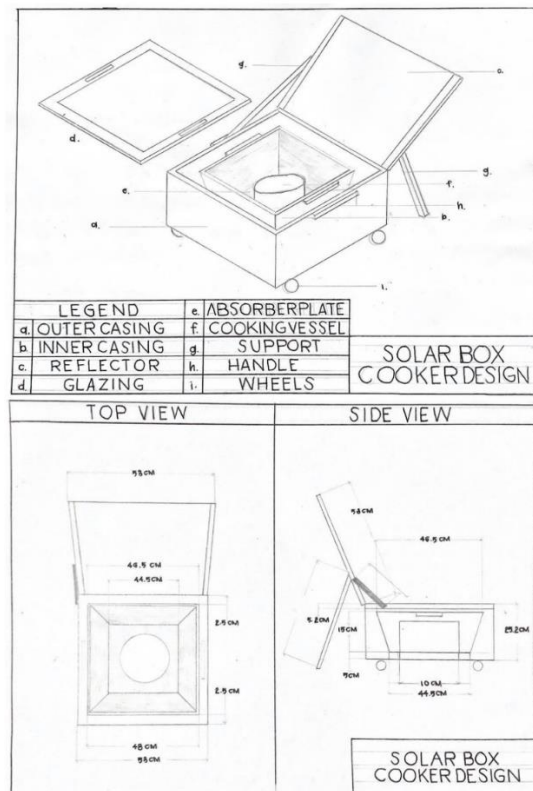


Figure 2 Schematic Diagram of the Solar Box Cooker

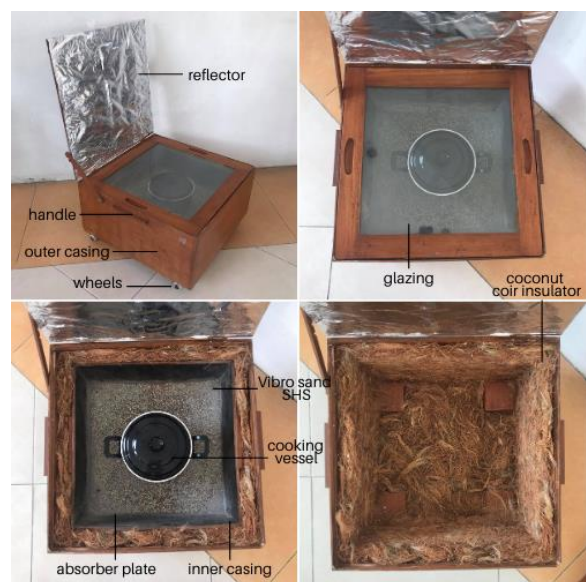


Figure 3 Constructed Solar Box Cooker

The solar box cooker consists of the following components: a plywood outer casing, plywood inner

casing lined with a black absorber plate made of Minola cooking oil tin can, aluminum foil reflector, windowpane glass as double glazing, black aluminum cooking pot, Vibro sand SHS material, and coconut coir (*Cocos nucifera*) insulator. Handles and wheels were also added for easy transportation and consumer use.

The prototype's components, materials, and design specifications were decided upon by reviewing the availability, efficiency, and cost of the materials and previous researchers' recommendations. The works of Weldu et al. (2019), Ademe and Hameer (2017), Yusuf et al. (2014), and Folaranmi (2013) were used as a reference, as they studied the features that facilitate increasing the efficiency of solar box cookers. No patent infringement is susceptible in the process of replicating specific details in their SBC design. An ethical acknowledgment of the ideas and works borrowed was given through proper citation.

## 2.2 Thermal Performance Testing and Evaluation

The solar box cooker's thermal efficiency was examined by conducting the Stagnation Temperature test from the Bureau of Indian Standards (BIS), the Cooking Power test from the American Societal of Agricultural Engineer (ASAE) standards, and a rice cooking test. These three tests were performed to determine the first figure of merit ( $F_1$ ), the standardized cooking power ( $P_{50}$ ), and the cooking time, respectively. Three-day trials were carried out for each performance test, and the mean data acquired were evaluated using criteria values. A digital anemometer, kitchen scale, solar power meter, and type K thermocouple wire and sensor were utilized.



**Figure 4** Stagnation Temperature Test Experimental Set-up

The Stagnation Temperature test presented and monitored the unloaded solar box cooker's time and temperature profile under the sun to determine the maximum attainable absorber plate temperature

(Aremu & Akinoso, 2013; Ademe & Hameer, 2018). The cooker was placed under the sun 30 minutes before the data collection to simulate cooking procedures when using the device and gauge how high the plate temperature could reach, supposing that it is preheated by consumers 30 minutes before cooking. The plate temperature ( $^{\circ}\text{C}$ ), ambient temperature ( $^{\circ}\text{C}$ ), solar insolation ( $\text{W}/\text{m}^2$ ), and wind speed ( $\text{m}/\text{s}$ ) were measured at every five-minute interval from 10:00 until it reached its quasi-steady state, which is identified using a given set of conditions. It is used to compute the performance index, the first figure of merit ( $F_1$ ), which depicts the cooker's ability to develop and retain maximum temperature (Kundapur & Sudhir, 2009). An  $F_1$  equal to or greater than 0.12 marks the device as a Grade A solar cooker, while less than 0.12 marks it as a Grade B solar cooker.



**Figure 5** Cooking Power Test Experimental Set-up

Cooking Power is defined as the rate of useful energy available during heating (Folaranmi, 2013; Ademe & Hameer, 2018). Linear regression analysis was used to determine the relationship between cooking power and temperature difference regarding intercepts and slopes using the standardized cooking power and temperature difference as the Y and X-axis (Weldu et al., 2019; Aremu & Akinoso, 2013). The water temperature ( $^{\circ}\text{C}$ ), ambient temperature ( $^{\circ}\text{C}$ ), solar insolation ( $\text{W}/\text{m}^2$ ), wind speed ( $\text{m}/\text{s}$ ) were recorded for every ten-minute interval to compute the two plots. The cooking power curve served as a tool in indicating the two essential performance parameters, mainly the cooker's capacity and heat retention abilities (Funk, 2000). In terms of prototype evaluation, the resulting coefficient of determination ( $R^2$ ) must exceed 0.75. The single measure of performance ( $P_{50}$ ) of the cooking power regression equation was another evaluation measure for the designed solar box cooker's performance that served as a unit for comparison.



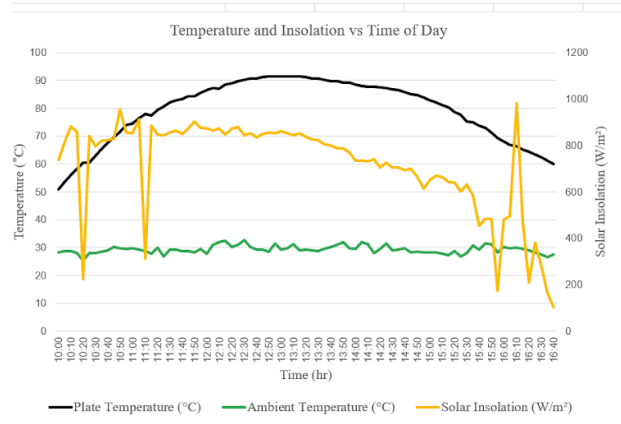
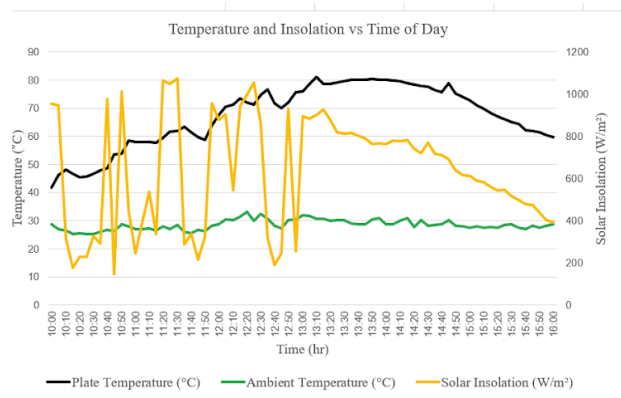
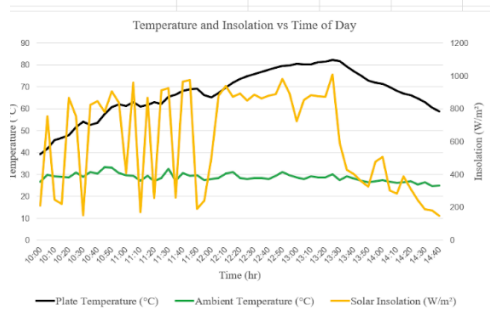
**Figure 6** Rice Cooking Test Experimental Set-up

The rice cooking test determined the device's thermal performance in terms of its rice cooking ability. The unloaded SBC was preheated under the sun at 8:30 to build up heat for 30 minutes. The cooking pot filled with 300 g NFA rice and 500 mL water was then placed on the absorber plate at 9:00. The pot's temperature (°C) and corresponding ambient temperature (°C), solar insolation (W/m<sup>2</sup>), and wind speed (m/s) were measured at every 15-minute interval. The cooking time was recorded once the rice is cooked, characterized by a firm texture and sticky consistency. The data were compared with other researchers to determine if sensible and realistic results were achieved. A cooking time of 120 to 180 minutes is manifested to be the ideal duration for a 300 g load of rice from the studies of Rikoto and Garba (2013) and Aremu et al. (2019).

### 3. RESULTS AND DISCUSSION

#### 3.1 Stagnation Temperature

The Stagnation Temperature test was carried out for three consecutive days from February 15 to 17, 2021. To identify the stagnation temperature needed for F<sub>1</sub> evaluation as set by the BIS (2000), variations of ±1°C for plate temperature, ±20 W/m<sup>2</sup> for solar radiation >600 W/m<sup>2</sup>, and ±0.2°C for ambient temperature must be complied with.



**Figure 7** From Top to Bottom: Temperature Variation Curve During Stagnation Temperature Test Days 1 to 3

**Table 1** Summary of Data from Days 1 to 3 of the Stagnation Temperature Test

	Day 1	Day 2	Day 3
<b>Highest Plate Temperature (°C)</b>	82.3	80.3	91.5
<b>Mean Ambient Temperature (°C)</b>	29.3	28.5	29.2
<b>Mean Solar Insolation (W/m<sup>2</sup>)</b>	716	644	824
<b>Mean Wind Speed (m/s)</b>	1.1	1.0	1.0
<b>F<sub>1</sub> (Km<sup>2</sup>/w)</b>	0.05	0.07	0.07

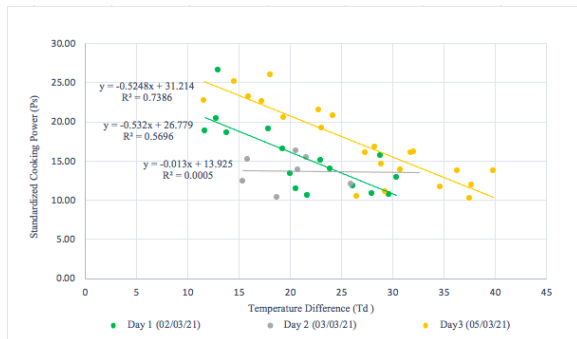
As shown in Figure 7, frequent cloud coverage during the first and second days led to the sharp alternating of high and low solar insolation outputs during the first two hours of the experiment. The highest plate temperature among the three trials was achieved during the third day due to relatively good radiation. The data obtained were insufficient to determine the optimal stagnation plate temperature due to high variations in ambient temperatures exceeding the ±0.2°C condition during the three-day trials.



The mean first figure of merit ( $F_1$ ) achieved by the cooker is found to be  $0.06 \text{ Km}^2/\text{w}$ , which is 50% of the BIS (2000) expected value of  $0.12 \text{ Km}^2/\text{w}$ . Thus, the designed SBC is classified as a Grade B solar cooker. The cooker's  $F_1$  value is lower than the values obtained by the SBCs of Folaranmi (2013), Weldu et al. (2019), and Aremu et al. (2019), who obtained figures of 0.11, 0.154, and a range of 0.9 to  $0.13 \text{ Km}^2/\text{w}$ , respectively. Despite this, the cooker reached plate temperatures above  $90^\circ\text{C}$  and sustained a temperature above  $75^\circ\text{C}$  for 265 minutes.

### 3.2 Cooking Power

The Cooking Power test was conducted on March 2, 3, and 5, 2021. The 2.310 kg water load was derived from the ASAE S580 (2013) standard of multiplying 7 kg by the cooker's intercept area. The standard cooking power ( $P_s$ ) was plotted against the temperature differences ( $T_d$ ), as shown in Figure 7. Data with wind speeds above 2.5 m/s were excluded to from meeting the ASAE S580 (2013) conditions on uncontrolled weather variables. Outliers caused by sudden cloud covers were also removed to allow statistically relevant results.

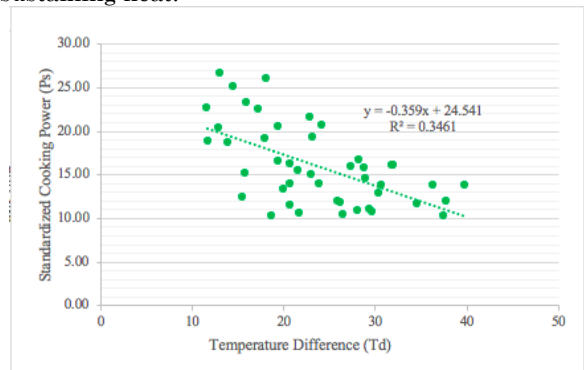


**Figure 8** Standard Cooking Power Plotted Over Temperature Difference

**Table 2** Summary of Data from Days 1 to 3 of the Cooking Power Test

		Day 1	Day 2	Day 3
Cooking Regression Equations	Intercepts (W)	26.78	13.93	31.21
	Slope ( $\text{W}/^\circ\text{C}$ )	-0.53	-0.013	-0.52
Coefficient of Determination ( $R^2$ )		0.57	0.0005	0.74
Mean Ambient Temperature ( $^\circ\text{C}$ )		34.5	30.3	30.2
Mean Solar Insolation ( $\text{W}/\text{m}^2$ )		770	573	813
Mean Wind Speed (m/s)		0.9	1.5	1.5

The initial standardized cooking power for the first, second, and third days are 26.78, 13.93, and 31.31 W, respectively, exhibiting the expected linear decrease as the cooking power begins at a high value and lowers as the temperature difference increases. Although the second day had sudden cloud covers that influenced the low average insolation record, the power regression equation showed a negative slope of  $-0.013 \text{ W}/^\circ\text{C}$ , which complimented the cooker's heat retention capabilities. The first and third trials exhibited an ideal power curve. The first day had cloudy conditions that caused outliers. In contrast, the third day had high average insolation owing to very minimal cloud coverage, presenting the optimal performance of the cooker in heating food and sustaining heat.



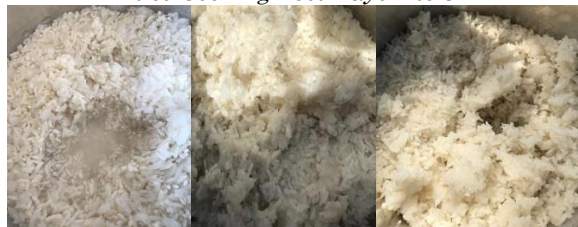
**Figure 9** Overall Cooking Power Performance

The cooking regression equation is  $P_s = 24.541 - 0.359 T_d$ . The standardized cooking power at  $50^\circ\text{C}$  temperature difference ( $P_{50}$ ) was determined as 6.651 W using the equation, which is lower compared to the results of Folaranmi (2013), Aremu and Akinoso (2013), and Weldu et al. (2019), as their figures are 23.95, 37.20, and 39.54 W, respectively. The coefficient of determination ( $R^2$ ) obtained was 0.35, which does not satisfy the standard value of the ASAE S580 (2013). This indicates that only 35% of the standardized cooking power's variation can be attributed to the temperature difference. The resulting values are due to low insolation caused by sudden cloud formations and the sun's intermittence every ten minutes during the first and second days.



### 3.3 Rice Cooking

**Figure 10** From Left to Right: Resulting Rice Load of Rice Cooking Test Days 1 to 3



**Table 3** Summary of Data from Days 1 to 3 of the Rice Cooking Test

	Day 1	Day 2	Day 3
<b>Highest Pot Temperature (°C)</b>	71.1	78.5	83.3
<b>Mean Ambient Temperature (°C)</b>	30.1	31.4	31.6
<b>Mean Solar Insolation (W/m<sup>2</sup>)</b>	467	730	723
<b>Mean Wind Speed (m/s)</b>	0.3	1.0	0.7
<b>End of Recording</b>	14:00	14:30	16:00

The rice cooking test was conducted from March 17 to 19, 2021. On the first day, the rice still had water and a hard and grainy texture, indicating that it was uncooked. Compared to the subsequent trials, the first day had the least sunlight availability. On the second day, the rice's top layer had a sticky texture with no water, while the bottom had a hard and grainy texture, indicating that it was partially cooked. As shown in Table 3, there was higher sunlight availability, increasing the water absorption compared to the first day. On the third day, the rice was firm, tender, and had a sticky texture, indicating that it was cooked. There were favorable weather conditions similar to the second day. Consequently, the cooking time was 420 minutes, which is slower than the results of Rikoto and Garba (2013) and Aremu et al. (2019). The frequent opening of the glazing and pot could have contributed to the obtained time.

## 4. CONCLUSION AND RECOMMENDATIONS

This study's overall objective seeks to manufacture a design equipped with readily available sensible heat storage material (SHS) and an insulator to improve solar box cookers' thermal efficiency for rural households in the Philippines. Despite the three performance tests' experimental results showing the

cooker's underperformance in fluctuating weather conditions, it highlights satisfactory results in sustaining heat inside the cooking chamber. The cooker's performance under unremitting solar radiation showed its ability to pasteurize water and cook rice.

Future research should center on developing designs that optimize available materials and solar radiation to improve an SBC's heat accumulation further. A comparative analysis of varying cooker configurations in different sites should also determine the most suitable design for a specific region in the Philippines.

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