Developing Plastic Prototype Jar for Food Preservation Quality and Safety

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Abstract

This study assessed a locally substitute polymer which is the polylactic acid (PLA) for traditional plastic packaging, which has problems for food quality, safety, and sustainability. The main goal was to designed, manufactured, and test a PLA-based jar for barangay-level food preservation. The study was conducted in three phases, gathering of sustainable materials, developing the jar using CAD design and 3D printing, and evaluating it for consumers input about the plastic prototype packaging jar. It was guided by a Research and Development strategy using the IPO model. Fifty respondents from Barangay Sta Filomena from San Pablo City, Laguna, ages 18 to 35 using stratified random sampling, took part. To gather the data validated surveys were used, ANOVA and other descriptive and inferential statistics were used for analysis. Findings revealed that the PLA-based jar was durable, safe, and well-accepted by consumers. It was rated as highly satisfied by the respondents for its features and functionality for food preservation. Through the statistical data, results confirmed the environmental relevance and practical value of the jar as an efficient alternative packaging material. The results suggested that the use of PLA-based plastic prototype packaging jar at the barangay and household community setting can promote sustainable practices, support food safety, and reduce reliance on conventional plastics.

Keywords: PLA; 3D Printing; Prototype; Packaging; Sustainable

1. Introduction

Different studies have cited that we can intake specific chemical present in food and beverage packages. Decreased in fertility rate and metabolic diseases such as obesity are a few that have been connected to health issues that we can get. Heat exposure can cause this leaching to happen even more quickly and thoroughly. This implies that just by heating your leftovers in a plastic packaging, you may be swallowing an even greater amount of potentially dangerous chemicals (Harvard Health, 2019). However, when transporting packed goods, lightweight plastic packing can save energy. Distributors, retailers, and customers all save money when there is a reduction in the amount of gasoline utilized and pollutants. Plastic packaging strength and sealability prolong shelf life by preventing product deterioration. Food loss in retailers can be decreased from 16 percent to 4 percent by using modified environment packaging composed of plastics, which can extend shelf life from 5 to 10 days (Federation, (n.d.-b). Food flavor and quality can also be negatively affected by plastic packaging. The flavor of the meal may be changed by the plastic taste that some polymers might cause. Furthermore, food can rot and lose flavor in plastic containers due to moisture retention. In line with U.S. Food and Drug Administration states that plastic containers that are not adequate for food could contaminate food. To ensure that plastic food containers are safe for food, they must adhere to strict rules.

There is plastic everywhere. It is kept in a variety of bottles and bags, along with bowls and wraps for food and drink storage. However, a growing number of people have been inquiring as to whether it is safe for us to expose our food to so much plastic. In our modern environment, the demand rate of plastic packaging has rise and become a need because of its affordability, durability, and ease of use for food storage and transportation. Food packaging made of plastic has permeated every aspect of our daily life. In order to keep our food fresh and free from infection, we utilize it for both storage and transportation. Negative effect of plastic food packaging on the environment and public health have been a concern (Mancuso, 2023). Food preservation plays an important part in our growing, modern culture on the daily phenomena. It ensures a safe and fresh food even when the food is not in season. Plastic packaging is one of the most popular form used in preservation of food. However, questions with regards to the impact of plastic packaging on food quality remains even with the transformation of the way we store and transport food. (Solution, 2023).

Protecting the food from deterioration and damage is the main purpose of food packaging while providing convenient transportation. Although there are various options plastic packaging is one of the most popular types of packaging because of its versatility in terms of use. In fact, the process used to produced plastic has advanced significantly over time. The goal of sustainable plastic packaging solution is to minimize the harmful effect of plastics. A great deal of study is put into finding sustainable methods of fabricate the material. With the use of bisphenol A-free polymers an ongoing advancement in the manufacturing of sustainable plastic items is utilize (Ferguson and Atchison, 2023). Parallel with this study, Swetha et al. (2023) provided a comprehensive review of PLA's potential in food packaging, noting that it is derived from renewable feedstocks, recognized by the FDA as Generally Recognized As Safe (GRAS), and versatile enough to be processed into films, trays, and shrink wraps. Its compostability further positions PLA as a cornerstone of sustainable packaging innovation (ScienceDirect).

Nobile, et al., 2003, found out in their study that making the outer wall of a plastic will not help much as oxygen still penetrates inside resulting from a change of taste and color. They suggested that using innovative materials that combine starch-PCL blend with an oxygen scavenger can increase the quality decay kinetics more slowly than glass bottles, resulting in a container that works better and has less of an impact on the environment. For PLA, this highlights the importance of airtight sealing mechanisms such as rubber gaskets or composite reinforcements in container design. Hassan et al., 2019 states that as natural biopolymers starches are a vital raw material that is widely used for the development of bio-based blends and composites as it comes from different grains like corn, cassava, potato, and rice.

However, according to the study of Humbert, et al., 2009, other factors play an important role in the packaging systems like transportation and not only the materials and preservation procedure made in their analysis of the alternatives of food packaging using glass jars and plastic pots.

Costumer engagement is ultimately one of the determinants of success sustainability, alternatives, and initiatives as key players in the implementation of a sustainable plastic economy (Grace, 2017). Customers between aged 18-35 were mostly drawn to glass packaging because of its transparent, protective structure and inherent health benefits, whereas costumers were drawn to plastic and paperboard packaging because of its ease of use and resistance to physical damage (Aday and Yener, 2014).

In conclusion, it is a challenging topic to discuss the impact of plastic packaging to food quality and safety. Plastic packaging can affect taste, texture, and nutrient content in addition to its undeniable benefits in extending shelf life and minimizing food waste. As a result, it is important to achieve the right balance by selecting adequate packing, following to storage regulations, and researching alternate materials. Ultimately, a wise consumption and good disposal practices can lessen the environmental impact of plastic packaging.

1.1. Background of the Study

The role of packaging in the food sector is huge since it affects food safety and quality, as well as shelf life and marketing communications. Conventional packaging of food offers product protection against deterioration and storage until they are eaten. To protect food items from dust, trash, moisture, heat and bacteria, plastic films have been used and in addition to promoting marketing, packaging displays nutritional data and branding (Yan et al., 2022). Plastic wrap works well to keep food fresh and is inexpensive. It is not recyclable, though, and it is not very strong. While glass jars are another popular kind of food packing. Glass jars may be recycled and are more robust than plastic wrap. They are less practical to use and cost more, though. According to Garcia et al., 2021, recycling has been done since man's first permanent settlements. They utilized tools out of materials like woods and stones. This kind of behavior was also seen in pre-Hispanic times, when tools made of wood, rocks, and animal bones were used.

Reusing waste and useless metal objects was done even after metallurgy emerged. About 2500 B.C., metal recycling began in China. Similar circumstances existed in classical Rome, when recycled glass was used to create their renowned mosaics. (Zhao et al., 2013)

Cocking and Manufacturers' Confederation 2003 underscored that reusing glass is one method that positively affects sustainability because this raw material can be used repeatedly periods. Maintaining its quality while converting it into a substitute raw material, which makes It's a compelling proposition.

Another one of the most popular forms of packaging in the food sector is plastic, which is frequently used to package both wet and dry goods. Another substance that is frequently used for plastic packaging is polyvinyl chloride, or PVC. It is possible that you have seen it on medication packaging, which includes adhesive tape, water bottle sleeves, cling film, and blister packs for tablets. However, the PVC has pros and cons to be considered. The benefits include inexpensive food packaging materials, the ability to package both dry and wet food items, resistance to environmental elements including moisture, the ability to directly mark plastics, and flexible packaging. The negative aspects include material that is difficult to recycle, negative reactions most plastic packaging to hot food, and harm to the environment (Lightstead et al., 2022).

Foods and packaging may react negatively, compromising the safety or quality of the product. Degradation mechanisms associated with meal packaging made of polymer-based materials include the leech of undesirable flavors from packaging to the food and flavor changes caused by aroma sorption. To maximize desired modifications while reducing unwanted alterations, packing material selection must carefully consider the factors influencing these interactions. This will improve product quality, safety, and shelf-life. Product factors include vitamin loss, microbial activity, color changes, susceptibility to flavor and related deteriorations, and accessible flavor concentration. Temperature, duration, and processing technique are factors to consider when storing. (Vasile and Baican 2021)

According to Alamri, et al., 2021, a vital factor to take into account is how it’s packaging and the food interact, particularly when the material comes in contact with the food. (Arvanitoyannis and Bosnea, 2004) The food and packaging materials interaction could impact the food quality, safety, and/or package integrity, which is regarded as an exchange between food, packaging, and the environment. Food packaging's primary objective is to shield food from the elements, but interactions between food and packaging could affect food, safety and/or quality. It is unpleasant and may change the flavor of food when additives are transferred in large quantities from packaging to the food itself. Other undesirable events include the food's attractive tastes being transferred to the packaging and the moisture being absorbed or released through penetration. It's interesting to think that this package-to-food interactions could improve food safety and quality. For example, in order to improve the stability of high-fat foods, various studies have recently been employed to build active component material for packaging that consumes oxygen rather than only functioning as a barrier to penetration.

According to Maloba et Al., 1996, "Active packaging" is defined as packaging intended to promote positive interactions with the food it contains. (Labuza and Breene, 1989) Three forms of the interactions might distinguish between food and packaging: absorption, diffusion, and migration. Examples include the migration of food additives, which may improve food quality, or the migration of contaminants or plasticizers from recycled plastic polymers, which is thought to be safety and regulatory concern. Other examples include the permeation of various gases, such as oxygen or carbon dioxide, which may be beneficial for modified atmosphere packaging, but undesirable for carbonated beverages, and the sorption of flavor and aroma, which may alter the organoleptic properties of foods.

The use of starch as a bio-based material for food packaging is growing because of its affordability, tastelessness, environmental friendliness, and accessibility. Compared to other polysaccharide and protein films, the thermoplastic starch film has stronger and superior mechanical properties. (Bumbudsanpharoke and Ko 2019) Many food products on the market are oxygen-sensitive, and extended exposure to them can cause changes in the food's flavor, color, and smell as well as encourage the growth of microorganisms. One way to lessen the amount of oxygen on food products is to add oxygen scavengers. As a kind of active packaging method, oxygen scavengers absorb dissolved oxygen or oxygen in the headspace, extending shelf life and maintaining food quality (Dey and Neogi 2019).

Most people are largely unaware of how plastic packaging affects food quality. Based on research, the majority of studies addressed the effects of plastic packaging on animal welfare, the environment, the convenience and adaptability of plastic use, and the promotion of recycling. The factors influencing these interactions must be carefully taken into account when choosing packaging materials in order to maximize desired changes while enhancing product quality, safety, and shelf life.

2. Methodology

This section contains the research design and the methodology to be used in the conduct of this study. It incorporates the sampling technique, sources of data, research subjects, population of the study, the instrument to be utilized to gather data as well as the statistical tool to be used.

2.1 Research Design

This study employed a Developmental Research Design, specifically following the Research and Development (R&D) model approach that designed, fabricated a prototyped, and evaluated the sustainability of the PLA Jar for barangay use. The process was guided by Borg and Gall (2003) adapted to suit the local context and educational objectives. The research design were used to investigate the impact of using various Plastic Packaging material on the Preservation Quality and Safety of Food Packaged Foods in Barangay Sta.

Felomina, San Pablo City, Laguna. Ritchey and Klein (2014) viewed developmental research as a field of instructional technology wherein researchers used it to establish a foundation for tools and product development. It is regarded as the most essential used research methodology. While a comparative approach is an analytical tool that identifies similarities and differences between phenomena by grouping them together (Shahrokh and Miri, 2019). Guided by the IPO (Input-Process-Output) model, this study unfolded in three phases: the first one is sourcing of materials, followed by development of the packaging jar and lastly, the evaluation of the features and functionality of the jar. This approach is appropriate for evaluating both the technical attributes and community reception of the developed packaging, especially in comparison to existing plastic materials.

2.2 Respondents of the Study

The respondents of the study are consisted of Fifty (50) consumers aged 18-35 years old residing in Barangay Sta. Filomena San Pablo City, Laguna, who used plastic as their packaging material for food storing and preservation. According to Aday and Yener 2014, consumers aged 18-35 years old were drawn to glass packaging because its transparent, protective structure and health benefits while consumers were drawn to plastic and paper board packaging because of its ease of use and resistance to physical damage.

2.3 Population and Sampling Technique

The researcher collected data through stratified random sampling technique. Simkus, 2023 define stratified random sampling technique as using a technique for breaking up a population into smaller groups, or strata, according to traits that they have in common. Then, chose a representative sample at random from each stratum. The participants were the residents who used plastic packaging in food preservation aged 18-35 years of age.

2.4 Research Instrument

The data collection method included a self-made surveys and questionnaires that were administered to consumers to gathered data on their perceptions and experiences regarding the use of developed plastic food packaging preservation material. To ensure the content validity of the survey instrument, the researcher employed a structured validation tool reviewed by a panel of experts in food science, engineer technology, and consumer behavior. Clarity and relevance of the statements were rated by experts using a 4 point Likert scale (1 = Poor, 4 = Excellent) for providing quality feedback.

Expert evaluation and feedback is important as it validated the content of the research instrument Polit and Beck (2004). This is explored further by Cobern and Adams (2020) to promote and enhance the use of item level ratings in consumer-focused research, it must be aligned to the concept and is language accurate.

Through the use of a methodical seven-step procedure for making an instrument, the MEASURE framework includes validation of expert and pilot testing as a necessary step that is developed by Kaklbrenner (2021). The need for clarity, relevancy and testing that use to validate the consumers opinions about packaging and environmental concerns are involved. These ensures a strong foundation for the validation strategy that the instrument is both methodological and contextual accurate.

2.5 Research Procedure

The development of the PLA jar is divided into three phases: sourcing of materials, fabrication and design and the evaluation of the developed prototype that is aligned with the regulatory context, suitable for its sustainability and community integration. The researcher conducted the following procedures

Product Development

Phase 1: Sourcing of Materials

Identifying the locally available sustainable materials for the prototyping of the PLA jar is the first step. Materials were sourced with the accredited supplier of the R&D facility, and is assessed and consulted for compatibility with 3D printing and food contact.

Phase 2: Development of the Jar

Initial designs were done and consulted with an expert on designing using CAD-based digital sketches. The design considered ergonomic features like safety locks, and therefore printed using 3D printing techniques.

Phase 3: Evaluation of the Developed Jar

The last phase is the evaluation of the features and functionality of the prototype plastic packaging jar through field testing and gathering of consumers feedbacks. It was tested for 3-5 days following the regulatory of the U.S. Food and Drug Administration (FDA) that approves the use of composite blends PCL and PLA up to 35% (Food Contact Notification No. 1761 (U.S. FDA, (2021). The National Academy of Science and Technology Philippines (NAST PHL, 2021) affirmed and encourages the use of bio-based polymers for its ease of use, safety, and biodegradability.

2. 6 Ethical Considerations

This study upholds strict ethical standards to protect the rights and privacy of all participants. All data collected were treated with confidentiality and anonymity. Participation is entirely voluntary, and students may withdraw from the study at any time without consequence. The interactive website remained accessible to all students, regardless of their participation status. Furthermore, all results reported in aggregate form to ensure individual responses are not identifiable.

2. 7 Statistical Treatment of Data

This study utilized descriptive and inferential statistics to examined the age-categorized data collected from Samples 1 through 4. To provide a profile of the sample, frequency and percentage were utilized to characterized the respondents' distribution across various age groups. In order to evaluate the efficacy of the plastic food packing materials, the standard deviation were quantified the variation of these values within each age group, and the mean were calculated to obtained the average food preservation quality score for each age group. The study utilized a one-way Analysis of Variance (ANOVA) to see if there are statistically significant differences in the quality of food preservation between the age-based groups.

3. Results and Discussion

This section presents the data gathered through the research instrument used. The following analyses and interpretations were presented according to the order of questions laid down in the survey questionnaires.

Table 1

Distribution of Respondents according to Age

Age	Frequency	Percent
18 – 20 years old	1	2.0 %
21 – 23 years old	1	2.0 %
24 – 26 years old	2	4.0 %
Above 26 years old	46	92.0 %
Total	**50**	**100.0 %**

In Table 1, out of the total 50 participants, the overwhelming majority, Ninety-two percent (92%) were aged above 26 years old. In contrast, only Two (2%) belonged to the 18–20 years old group, and another 2% were within the 21–23 years old bracket. A small proportion, Four (4%), fell within the 24–26 years old category. These findings suggest that older respondents make up the majority of the sample. This implies that people with more home experience and maturity affected the evaluation of the developed plastic packaging jar, which may have contributed to their favorable opinion of its features and functionality.

Table 2
Perceived level of consumers satisfaction with the Jar's features of plastic packaging jar in terms of: Affordability

Indicators	Mean	Std. Deviation	Interpretation
1. The jar is reasonably priced for everyday household use.	5.00	0.00	Highly Satisfied
2. The cost of the jar matches its quality and performance.	4.96	0.20	Highly Satisfied
3. The jar offers good value for money.	4.86	0.35	Highly Satisfied
4. The jar is affordable compared to other food storage options.	4.90	0.30	Highly Satisfied
5. The price of the jar is acceptable for bulk or community use.	4.94	0.24	Highly Satisfied
6. The jar's price encourages sustainable and repeated use.	4.92	0.27	Highly Satisfied
7. The jar's cost is competitive compared to similar locally available products.	4.96	0.20	Highly Satisfied
Overall	**4.93**	**0.22**	**Highly Satisfied**

Legend: *4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS) 1.00-1.49- Not Satisfied (NS)*

In Table 2, results showed that the respondents strongly believed that the jar is okay for everyday use and is affordable which led to an overall mean score of 4.93 (SD = 0.22) which is rated as Highly Satisfied. Its price is competitive with other locally made products as well as its performance and quality. Costumers valued the cost of the jar and implies that the jar is both socially and economically okay for wider use.

Table 3
Perceived level of consumers satisfaction with the Jar's features of plastic packaging jar in terms of: Durability

Indicators	Mean	Std. Deviation	Interpretation
1. The jar withstands repeated use without damage.	4.90	0.30	Highly Satisfied
2. The jar remains intact even when exposed to heat or moisture.	4.94	0.24	Highly Satisfied

3. The lid and body of the jar are resistant to cracking or warping.	4.92	0.27	Highly Satisfied
4. The jar maintains its structural integrity during storage and transport.	4.88	0.33	Highly Satisfied
5. The jar feels sturdy and reliable for long-term use.	4.92	0.27	Highly Satisfied
6. The jar resists scratches and dents during handling.	4.82	0.39	Highly Satisfied
7. The jar remains functional even after minor accidental drops.	4.82	0.39	Highly Satisfied
Overall	**4.89**	**0.31**	**Highly Satisfied**

Legend: *4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS) 1.00-1.49- Not Satisfied (NS)*

Durability in Table 3 is rated as Highly Satisfied with an overall mean score of 4.89. The respondents observed that the structural integrity of the jar when being stored and transported can resists damage or cracking. Because of this, the jar is both appropriate for household and community use for food preservation.

Table 4

Perceived level of consumers satisfaction with the Jar's features of plastic packaging jar in terms of: Color

Indicators	Mean	Std. Deviation	Interpretation
1. The jar's color is visually appealing.	4.96	0.20	Highly Satisfied
2. The color of the jar complements typical kitchen or pantry settings.	4.96	0.20	Highly Satisfied
3. The jar's color helps identify its contents easily.	4.86	0.40	Highly Satisfied
4. The color remains vibrant and does not fade over time.	4.84	0.37	Highly Satisfied
5. The jar's color enhances its overall appearance.	4.84	0.37	Highly Satisfied
6. The color is clear and consistent.	4.90	0.30	Highly Satisfied

7. The color is suitable for everyday household use.	4.80	0.40	Highly Satisfied
Overall	**4.88**	**0.32**	**Highly Satisfied**

Legend: *4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)*
1.00-1.49- Not Satisfied (NS)

In Table 4, the consumers were very satisfied with jar's color retention and was rated as Highly Satisfied with an overall mean score of 4.88 (SD = 0.32), which shows that they are happy with how the jar preserve and present food in a very appealing way. The highest statement with the mean score of 4.96 (SD = 0.20), "The jar's color is visually appealing" means that the consumers strongly appreciated and valued the appeal and ability of the jar to blend in home settings.

Table 5
Perceived level of consumers satisfaction with the Jar's features of plastic packaging jar in terms of: Texture

Indicators	Mean	Std. Deviation	Interpretation
1. The jar's surface feels smooth and pleasant to touch.	4.98	0.14	Highly Satisfied
2. The texture of the jar makes it easy to grip and handle.	4.90	0.30	Highly Satisfied
3. The jar's texture contributes to its durability.	4.78	0.42	Highly Satisfied
4. The jar's finish is consistent and free from defects.	4.82	0.39	Highly Satisfied
5. The texture of the jar supports safe and hygienic use	4.96	0.20	Highly Satisfied
6. The jar's texture prevents slipping during use.	4.90	0.30	Highly Satisfied
7. The jar's surface is resistant to stains and residue.	4.94	0.24	Highly Satisfied
Overall	**4.90**	**0.28**	**Highly Satisfied**

Legend: *4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)*
1.00-1.49- Not Satisfied (NS)

In Table 5, the results describes the excellent qualities of the jar in terms of its texture that suggests that the consumers were satisfied with the jars usability and safeness which they rated as Highly Satisfied

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with an overall mean score of 4.90 (SD = 0.28), that reflects the consumers confidence and trust in the jars ability to lessen contamination and maintain its cleanliness for household products.

Taken together, these results show that the jar's texture is a major strength, with smoothness, hygiene, and stain resistance being its most celebrated qualities. The jar's texture enhances comfort, safety, and confidence in product usability, making it a key factor in consumer approval.

Table 6

Perceived level of consumers satisfaction with the Jar's features of plastic packaging jar in terms of: User-friendly

Indicators	Mean	Std. Deviation	Interpretation
1. The jar is easy to open and close.	4.96	0.20	Highly Satisfied
2. The jar's design allows for convenient cleaning.	4.90	0.30	Highly Satisfied
3. The jar is simple to use for all age groups.	4.94	0.24	Highly Satisfied
4. The jar's features are intuitive and practical.	4.88	0.33	Highly Satisfied
5. The jar supports hassle-free food storage and retrieval.	4.94	0.24	Highly Satisfied
6. The jar's wide opening allows easy access to contents.	4.90	0.30	Highly Satisfied
7. The jar is lightweight and easy to carry.	4.92	0.27	Highly Satisfied
Overall	**4.92**	**0.27**	**Highly Satisfied**

Legend: 4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)
1.00-1.49- Not Satisfied (NS)

In Table 6, the total mean score for user-friendliness was 4.92 (SD = 0.27), which is considered Highly Satisfied. Respondents believed that easy access and use of the packaging jar is essential and age appropriate for consumers which results to a rating of 4.922 (SD = 0.27) which is considered as Highly Satisfied. The jars big opening makes it a good food storage. This suggests that convenience and accessibility are to consumer satisfaction, particularly for goods meant for a wider range of consumers.

Table 7

Perceived level of consumers satisfaction with the Jar's features of plastic packaging jar in terms of: Appearance

Indicators	Mean	Std. Deviation	Interpretation
1. The jar has a clean and modern design.	4.98	0.14	Highly Satisfied

2. The jar looks attractive when displayed or stored.	5.00	0.00	Highly Satisfied
3. The jar's appearance reflects quality and care in design.	4.82	0.39	Highly Satisfied
4. The jar's visual appeal enhances its usability.	4.94	0.24	Highly Satisfied
5. The jar's overall look is suitable for household and community use.	4.94	0.24	Highly Satisfied
6. The jar's design aligns with modern sustainability trends.	4.92	0.27	Highly Satisfied
7. The jar's appearance makes it suitable for gift-giving or community distribution.	4.96	0.20	Highly Satisfied
Overall	**4.94**	**0.21**	**Highly Satisfied**

Legend: *4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)*
1.00-1.49- Not Satisfied (NS)

Consumers in Table 7 are attracted to the jars aesthetic appearance which is suitable for today's modern trends. The results suggest that the jar is okay with a wider community adaptations which received the highest overall mean score of 4.94 (SD = 0.21). The jars clean, modern and sustainable design was praised for its attractiveness in household display.

Table 8

Summary of the perceived level of consumers satisfaction with the jar's features of plastic packaging jar.

Jars Features	Overall mean score	Std. Deviation	Interpretation
Affordability	4.93	0.22	Highly Satisfied
Durability	4.89	0.31	Highly Satisfied
Color	4.88	0.32	Highly Satisfied
Texture	4.90	0.28	Highly Satisfied
User-friendly	4.92	0.27	Highly Satisfied
Appearance	4.94	2.21	Highly Satisfied

Legend: 4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)

1.00-1.49- Not Satisfied (NS)

In Table 8, the consumers showed excellent satisfaction across all food samples. The results shows that scores from 4.88 to 4.94 are all rated as Highly Satisfied. The continuously high rating suggests that the product satisfies the consumers expectations in terms of its features and functionality.

The results indicate that the jars effectivity balanced the cost, practicality, and visual appeal of the product that appeals to consumers. This satisfaction confirms the jars features and design work well, making them a great alternative packing solutions.

and design work well, making them a dependable option for packing requirements.

Table 9

Perceived level of consumers satisfaction with the Jar's food preservation quality in terms of: Flavor

Indicators	Mean	Std. Deviation	Interpretation
1. The preserved food retained its original flavor after storage.	4.88	0.33	Highly Satisfied
2. The jar prevented flavor loss during the preservation period.	4.68	0.65	Highly Satisfied
3. The taste of the food remained consistent and enjoyable.	4.76	0.43	Highly Satisfied
4. The packaging did not alter or affect the food's flavor.	4.58	0.54	Highly Satisfied
5. The flavor quality met my expectations for preserved food.	4.72	0.45	Highly Satisfied
6. The jar preserved the food's seasoning balance.	4.84	0.42	Highly Satisfied
7. The jar maintained freshness without artificial additives.	4.74	0.49	Highly Satisfied
Overall	**4.74**	**0.47**	**Highly Satisfied**

Legend: 4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)

1.00-1.49- Not Satisfied (NS)

In Table 9, the jar preserved the taste and quality of stored food which results rated as Highly Satisfied with an overall mean score of 4.74 (SD = 0.47) showing that consumers were very satisfied with jars flavor retention. The statement "The preserved food retained its original flavor after storage" indicates a strong confidence that the jar is effective and can maintain the foods natural taste. This suggests that the jars packaging design supports freshness and flavor retention.

Table 10
Perceived level of consumers satisfaction with the Jar's food preservation quality in terms of: Aroma

Indicators	Mean	Std. Deviation	Interpretation
1. The preserved food maintained its natural aroma.	4.92	0.27	Highly Satisfied
2. The jar effectively contained the food's scent without leakage.	4.80	0.45	Highly Satisfied
3. The aroma remained pleasant and recognizable after storage.	4.76	0.56	Highly Satisfied
4. The packaging did not introduce any unwanted odors.	4.70	0.54	Highly Satisfied
5. The aroma quality contributed positively to the overall food experience.	4.80	0.40	Highly Satisfied
6. The jar preserved aroma even after reheating.	4.80	0.45	Highly Satisfied
7. The jar prevented cross-contamination of scents between jars.	4.90	0.30	Highly Satisfied
Overall	4.81	0.43	**Highly Satisfied**

Legend: 4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)
1.00-1.49- Not Satisfied (NS)

In Table 10, the respondents underscore the performance of the jar in maintaining the sensory qualities. The result was interpreted as Highly Satisfied, with an overall mean of 4.81 (SD = 0.43) which means that the jar is effect in preserving its natural aroma without leakage after storage. This strong performance contribute significantly to consumer satisfaction and enjoyment of preserved food.

Table 11

Perceived level of consumers satisfaction with the Jar's food preservation quality in terms of: Color

Indicators	Mean	Std. Deviation	Interpretation
1. The preserved food retained its original color and vibrancy.	4.86	0.35	Highly Satisfied
2. The packaging prevented discoloration during storage.	4.78	0.42	Highly Satisfied
3. The food remained visually appealing after preservation.	4.84	0.42	Highly Satisfied
4. The jar protected the food from light-related color changes.	4.86	0.35	Highly Satisfied
5. The color of the food matched its fresh counterpart.	4.84	0.42	Highly Satisfied
6. The jar maintained food brightness and appeal.	4.84	0.37	Highly Satisfied
7. The jar's transparency allowed easy monitoring of food color.	4.94	0.24	Highly Satisfied
Overall	**4.85**	**0.37**	**Highly Satisfied**

Legend: 4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49-Less Satisfied (LS) 1.00-1.49- Not Satisfied (NS)

In Table 11, the consumers were very satisfied with how visually the jar can store and retain the original color of the food. With an overall mean score of 4.85 (SD = 0.37), rates as Highly Satisfied, it suggests that respondents greatly valued the practicality of being able to visually check the food quality, ensuring that it still remains visually appealing, fresh looking and easy to monitor while avoiding any discoloration. In conclusion, the jar's performance in terms of color retention strongly supports consumer satisfaction, which supports its ability as a packaging solution.

Table 12

Perceived level of consumers satisfaction with the Jar's food preservation quality in terms of: Shelf Life

Indicators	Mean	Std. Deviation	Interpretation
1. The food remained safe to consume within the expected shelf life.	4.92	0.27	Highly Satisfied

2. The jar extended the food's freshness beyond typical storage duration.	4.80	0.40	Highly Satisfied
3. The packaging prevented early spoilage or contamination.	4.80	0.40	Highly Satisfied
4. The preserved food showed no signs of deterioration over time.	4.86	0.35	Highly Satisfied
5. The shelf life was appropriate for household or community use.	4.74	0.44	Highly Satisfied
6. The jar minimized waste by prolonging usability of food.	4.82	0.44	Highly Satisfied
7. The jar's seal reduced contamination risks.	4.84	0.37	Highly Satisfied
Overall	**4.83**	**0.38**	**Highly Satisfied**

Legend: 4.50-5.00- Highly Satisfied (HS): 3.50-4.49- Satisfied (S) : 2.50-3.49-Moderate (M): 1.50-2.49- Less Satisfied (LS)
1.00-1.49- Not Satisfied (NS)

Shelf life preservation received an overall mean of 4.83 (SD = 0.38), interpreted as *Highly Acceptable*. Respondents emphasized that the jar extended freshness, minimized spoilage, and reduced food waste. This finding underscores the jar's contribution to food security and sustainability. The jar effectively preserved food quality across flavor, aroma, color, and shelf life. These results reinforce its performance as a reliable packaging solution that supports both household and community food preservation needs.

Table 13
Perceived level of consumers satisfaction with the Jar's food preservation quality in terms of:

Food Preservation Quality	Overall mean score	Std. Deviation	Interpretation
Flavor	4.74	0.47	Highly Satisfied
Aroma	4.81	0.43	Highly Satisfied
Color	4.85	0.37	Highly Satisfied
Shelf life	4.83	0.38	Highly Satisfied

The perceived level of consumer satisfaction with the jars food preservation quality is shown in Table 13. The gathered data present that respondents are extremely satisfied with the jars characteristic to preserve the qualities of the stored food. It is rated as Highly Satisfied across all features demonstrating that the jar perform well which makes it as a reliable packaging solutions that attracts consumers.

Table 14

Perceived level of consumers acceptability of the preserved food and in the use of plastic packaging jar: PINAKSIW

Indicators	Mean	Std. Deviation	Interpretation
1. The Pinaksiw sample remained fresh and flavorful after storage.	4.92	0.27	Highly Acceptable
2. The packaging prevented strong odors from escaping.	4.66	0.56	Highly Acceptable
3. The texture of the fish and sauce remained acceptable.	4.86	0.35	Highly Acceptable
4. The sample showed no signs of spoilage or discoloration.	4.52	0.76	Highly Acceptable
5. The Pinaksiw was easy to store and reheat.	4.88	0.33	Highly Acceptable
6. The sour flavor balance was retained.	4.88	0.33	Highly Acceptable
7. The sauce consistency remained stable after storage.	4.94	0.31	Highly Acceptable
Overall	4.81	0.42	**Highly Acceptable**

Legend: *4.50-5.00- Highly Acceptable (HA): 3.50-4.49- Acceptable (A) : 2.50-3.49-Neutral (M): 1.50-2.49- Less Acceptable (LA)*
1.00-1.49- Not Acceptable (NA)

Table 14 shows that Pinaksiw preserved in the created plastic packaging jar receives consistently high evaluations for every attribute. The durability of the sauce consistency (M = 4.94) and the preservation of the sour flavor balance (M = 4.88) were especially appreciated by consumers. With a mean of (M = 4.52), spoiling prevention and discoloration control were also within the "Highly Acceptable" level. This shows that the packaging was most successful in preserving sensory attributes including flavor and texture.

Table 15

Perceived level of consumers acceptability of the preserved food and in the use of plastic packaging jar: ADOBO

Indicators	Mean	Std. Deviation	Interpretation

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1. The Adobo sample retained its rich flavor and aroma.	4.88	0.39	Highly Acceptable
2. The packaging prevented oil separation and leakage.	4.60	0.61	Highly Acceptable
3. The meat remained tender and visually appealing.	4.82	0.39	Highly Acceptable
4. The sample showed no signs of spoilage.	4.56	0.70	Highly Acceptable
5. The Adobo was easy to store and reheat.	4.84	0.37	Highly Acceptable
6. The sauce consistency remained thick and flavorful.	4.82	0.44	Highly Acceptable
7. The savory-salty balance was preserved.	4.88	0.44	Highly Acceptable
Overall	**4.77**	**0.48**	**Highly Acceptable**

Legend: *4.50-5.00- Highly Acceptable (HA): 3.50-4.49- Acceptable (A) : 2.50-3.49-Neutral (M): 1.50-2.49- Less Acceptable (LA)*
1.00-1.49- Not Acceptable (NA)

Table 15 shows that the Adobo stored in a packaging jar received the overall mean score of 4.77 which was rated as Highly Acceptable. The results suggest that the jar is able to keep oil from separating and leaking which shows that they can handle natural properties of oily foods. The packaging demonstrated strong performance in maintaining tenderness, sauce consistency, and ease of storage, making it highly suitable for meat based preparations.

Table 16
Perceived level of consumers acceptability of the preserved food and in the use of plastic packaging jar: ORANGE

Indicators	Mean	Std. Deviation	Interpretation
1. The Orange sample remained juicy and fresh.	4.92	0.34	Highly Acceptable
2. The packaging prevented drying or moisture loss.	4.74	0.56	Highly Acceptable
3. The fruit retained its natural color and texture.	4.84	0.42	Highly Acceptable
4. The sample showed no signs of mold or spoilage.	4.64	0.60	Highly Acceptable
5. The Orange was easy to access and reseal.	4.84	0.47	Highly Acceptable
6. The fruit segments stayed intact after storage.	4.76	0.43	Highly Acceptable
7. The packaging supported safe transport without bruising.	4.72	0.67	Highly Acceptable
Overall	**4.78**	**0.50**	**Highly Acceptable**

Legend: *4.50-5.00- Highly Acceptable (HA): 3.50-4.49- Acceptable (A) : 2.50-3.49-Neutral (M): 1.50-2.49- Less Acceptable (LA)*
1.00-1.49- Not Acceptable (NA)

The Orange sample received its highest rating for juiciness and freshness retention (M = 4.92), confirming the jar's effectiveness in preserving fruit quality. Transport protection against bruising also attained a "Highly Acceptable" rating (M = 4.72), reflecting the jar's ability to safeguard fruits during handling. In addition, attributes such as color retention, moisture preservation, and resealability were all rated highly, demonstrating that the packaging is well-suited for fruit storage and consumption.

Table 17

Perceived level of consumers acceptability of the preserved food and in the use of plastic packaging jar: GINISANG AMPALAYA

Indicators	Mean	Std. Deviation	Interpretation
1. The Ginisang Ampalaya retained its natural bitterness and flavor.	4.94	0.24	Highly Acceptable
2. The packaging prevented odor leakage from sautéed ingredients.	4.70	0.65	Highly Acceptable
3. The vegetables remained crisp and colorful.	4.86	0.40	Highly Acceptable

4. The sample showed no signs of spoilage or sogginess.	4.74	0.44	Highly Acceptable
5. The Ginisang Ampalaya was easy to store and reheat.	4.88	0.44	Highly Acceptable
6. The sautéed flavor balance remained intact.	4.78	0.46	Highly Acceptable
7. The vegetables did not become overly oily.	4.78	0.55	Highly Acceptable
Overall	**4.81**	**0.45**	**Highly Acceptable**

Legend: *4.50-5.00- Highly Acceptable (HA): 3.50-4.49- Acceptable (A) : 2.50-3.49-Neutral (M): 1.50-2.49- Less Acceptable (LA)*
1.00-1.49- Not Acceptable (NA)

The Ginisang Ampalaya sample achieved its highest rating in retaining natural bitterness and flavor (M = 4.94), highlighting the jar's ability to preserve authentic taste. Odor containment also reached a "Highly Acceptable" rating (M = 4.70), showing that the packaging effectively managed the aroma of sautéed dishes. Consumers further appreciated its performance in maintaining crispness, color, and ease of reheating, making it a strong option for vegetable-based preparations.

Taken collectively, the findings across the four food samples provide strong evidence that the developed plastic packaging jar functions as a highly effective and versatile medium for food preservation. The consistently high mean ratings, all within the "Highly Acceptable" range, underscore its capacity to maintain essential sensory attributes, with flavor retention emerging as the most prominent strength. This outcome highlights the jar's ability to safeguard the qualities most valued by consumers taste, aroma, and texture across diverse food categories including meat, fruit, and vegetables. Overall, the results affirm that the packaging jar not only meets consumer expectations for quality preservation but also demonstrates significant potential for broader application in food storage and distribution.

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Table 18

Significant difference in the perceived level of consumer satisfaction with the jars features of plastic packaging jar when group according to age.

Age		**Sum of squares**	**Df**	**Mean square**	**F**	**Sig.**
Affordability	Between groups	0.01	3	0.00	0.42	0.74
	Within Groups	0.52	46	0.01		
	Total	0.53	49			
Durability	Between groups	0.01	3	0.00	0.42	0.73
	Within Groups	0.52	46	0.01		
	Total	0.53	49			
Color	Between groups	0.06	3	0.02	0.74	0.53
	Within Groups	1.30	46	0.03		
	Total	1.36	49			
Texture	Between groups	0.05	3	0.02	0.70	0.56
	Within Groups	1.02	46	0.02		
	Total	1.06	49			
User-friendly	Between groups	0.02	3	0.00	0.40	0.76
	Within Groups	0.80	46	0.01		
	Total	0.82	49			
Appearance	Between groups	0.01	3	0.00	0.41	0.74
	Within Groups	0.64	46	0.01		

The statistical comparison of customer satisfaction with the physical attributes of the jar's affordability, durability, color, texture, user-friendliness, and appearance when categorized by age is shown in Table 16. All features had p-values greater than 0.05, according to the data, suggesting that there is no discernible variation in satisfaction levels between age groups. For instance, attractiveness had an F-value of 0.410 and a significance level of 0.747, whilst affordability and durability both had an F-value of 0.422 and a significance level of 0.738. These results imply that consumers of different ages have comparable perceptions of the jar's characteristics. The consistency in satisfaction suggests that there is no need for age-specific adjustments to the packaging design because it is widely accepted.

Table 19

Significant difference in the perceived level of consumer satisfaction with the food preservation quality of the developed packaging jar when group according to age.

Age		Sum of squares	Df	Mean square	F	Sig.
Flavor	Between groups	0.13	3	0.04	0.91	0.44
	Within groups	2.12	46	0.05		
	Total	2.25	49			
Aroma	Between groups	0.13	3	0.04	0.91	0.44
	Within groups	2.12	46	0.05		
	Total	2.25	49			
Color	Between groups	0.15	3	0.05	1.32	0.28
	Within groups	1.69	46	0.04		
	Total	1.84	49			
Shell	Between groups	0.15	3	0.05	1.31	0.28

Within groups	1.69	46	0.04

Table 19 examines how satisfied customers are with the jar's flavor, scent, color, and shell in relation to various age groups. The F-value for flavor and aroma was 0.912, and the significance threshold was 0.443. All other indicators produced non-significant p-values, which ranged from 0.280 to 0.443. This suggests age has little bearing on how consumers view a jar's capacity to maintain food quality. Customers gave the jar's preservation performance a constant rating regardless of age, confirming its acceptance across all demographic groups.
The findings from both tables **confirm that age did not affect** how satisfied customers are with the jar's appearance or ability to preserve food. The jar's global appeal is supported by its constancy across age groups, which also implies that its functioning and design generally satisfy customer expectations.

4. Conclusion and Recommendations

Since the findings revealed that there is no significant difference between the samples across age groups, the hypotheses on this regard are accepted. This indicates that perceptions of the PLA-based jar's effectiveness and sustainability are consistent regardless of age, further validating its potential as a universally acceptable packaging solution. Therefore, the study concludes that PLA is a viable and sustainable packaging material at the community level. Its integration into local food preservation practices not only addresses issues of plastic waste but also promotes environmentally responsible innovation aligned with regional needs.

The findings affirm the strong potential of the packaging jar, and several opportunities for enhancement and expansion can further maximize its impact. Refining its features to better manage oil separation in meat-based dishes and improving odor containment for sautéed foods will strengthen consumer satisfaction. At the same time, extended shelf-life studies and trials with other food categories such as soups, leafy vegetables, and dairy products can broaden its applicability, while exploring consumer perceptions under different storage conditions will provide valuable insights into usage flexibility. Practically, the jar can be promoted for household use, emphasizing convenience in storage, reheating, and sustainability. Its adoption by small-scale food enterprises can support safe and eco-friendly food distribution, and integrating these findings into community-based food preservation programs will contribute to local food security initiatives.

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