

Development and Evaluation of RFPs for Bamboo Shoot Products Through Drop Testing

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Abstract

Packaging functionality not only differentiates food products but also conveys brand identity. With increasing demand for shelf-stable and convenient products like bamboo shoot meals, innovative packaging is crucial. However, limited research evaluates the durability of Retortable Flexible Pouches (RFPs) through drop tests. This study assessed RFPs durability using performance drop tests. Consumer preferences were analyzed through a questionnaire, and the packaging design was developed using Adobe Photoshop. Data analysis was conducted using IBM SPSS Statistics 27, and drop tests were performed according to ASTM standards. A gusset folder box was designed to contain RFP products, which were Sample A (dry-textured bamboo shoots) and Sample B (wet-textured bamboo shoots). Each sample was cushioned with single-layer bubble wrap, double-layer bubble wrap, or inflatable air bubbles and dropped in six positions: top, bottom, right, left, right, and left corner sides. G values, measuring impact stress, were recorded during the tests. Findings showed 68% of respondents preferred medium-sized packaging (250g–500g), 72% favored freshness designs, 65% prioritized informative labeling, and 58% preferred high-quality imagery. Although medium-sized packaging was preferred, a 100g quantity was developed as suitable, balancing product characteristics, functionality, and effective sterilization. Inflatable air bubbles emerged as the most effective cushioning material, recording the lowest G values (28 G for Sample A and 29.6 G for Sample B). In contrast, the top side recorded the highest G values (364.4 G for Sample A and 358.2 G for Sample B with single-layer bubble wrap). These results highlight inflatable air bubbles' effectiveness in protecting RFPs of bamboo shoot products.

1. Introduction

Packaging is an essential system that ensures product protection, storage, transportation, and presentation. As consumer preferences evolve, packaging has expanded its role beyond functionality to become a strategic tool for brand communication [1]. Effective packaging not only preserves food quality but also influences purchasing

behavior through design features such as graphics, color, and convenience [2]. This dual functionality is especially vital in the food industry, where well-designed packaging not only protects the product but also enhances consumer satisfaction and loyalty [3].

Bamboo shoots, recognized for their nutritional value, require specialized packaging to maintain freshness and quality. They are rich in nutrients such as dietary fiber and bioactive compounds, which make them valuable food products [4]. However, their delicate nature and susceptibility to spoilage demand innovative packaging approaches to ensure product integrity [5]. Traditional packaging methods, such as cans and glass jars, present limitations, including weight, fragility, and reduced sustainability. Retortable Flexible Pouches (RFPs) have emerged as an innovative solution, offering lightweight, flexible, and eco-friendly alternatives that preserve product integrity while addressing consumer demands for convenience. RFPs have emerged as an innovative solution, offering lightweight, flexible, and eco-friendly alternatives that preserve product integrity while addressing consumer demands for convenience [6].

Most retort pouches are constructed with a four-ply laminate consisting of the innermost layer, made of polypropylene, which directly contacts the food and offers a heat-seal surface, flexibility, and strength. Nylon is included for its abrasion resistance, enhancing the pouch's durability. Aluminum foil serves as a crucial barrier layer, protecting the contents from light, gases, and odors, thereby extending shelf life. The outermost layer, polyester, provides a printable surface and additional strength. Together, these layers ensure the retort pouch effectively preserves the quality and safety of its contents during storage and handling [7].

RFPs are multilayered structures designed to withstand high-temperature sterilization processes, providing excellent barrier properties against light, gases, and moisture. Incorporating aluminum foil enhances their resistance to environmental factors, while polypropylene layers improve their sealing performance [8]. This design ensures product safety and prolongs shelf life, making RFPs ideal for preserving perishable goods in modern food packaging [9]. Evaluating the performance of RFPs is crucial to ensuring their reliability during transportation and handling. Drop tests, governed by standards such as ASTM D5276, assess the ability of packaging to protect contents from mechanical shocks and impacts [10]. These tests simulate real-world conditions, examining factors such as impact resistance and material durability to optimize packaging design for both functionality and sustainability [11].

The packaging industry makes extensive use of corrugated board due to its environmental advantages, resilience, and cushioning capabilities. A fluted corrugating medium and flat liner boards provide a novel construction that improves durability and efficiently protects items. The paper type, flute shape, and environmental elements like humidity and temperature are some of the variables that determine the strength of corrugated boards [12]. A corrugated board's unusual mix of flat and fluted layers gives it a high strength-to-weight ratio and is essential to its manufacturing. Using cushioning materials may help keep things safe during transportation by absorbing shocks and impacts. Honeycomb and molded pulp are two examples of paper-based products that are both recyclable and kind to the environment. While foams such as polyurethane and polyethylene provide excellent shock absorption, they are not particularly eco-friendly. However, they significantly reduce peak acceleration forces, thereby enhancing product protection under dynamic loading conditions [13]. Lightweight and effective in preventing objects from shifting, air-filled materials like bubble wrap are ideal for shipping. Inflatable air bubble systems are highly effective in uniformly dispersing impact forces across the packaging structure, minimizing the risk of damage to delicate items [14]. The fragility, weight, and sustainability value of the product are elements that determine the choice of cushioning [15]. Figure 1 shows that most items are typically provided in a box, which is placed on cushioning material, and both are enclosed in a corrugated cardboard box that serves as a package [16].

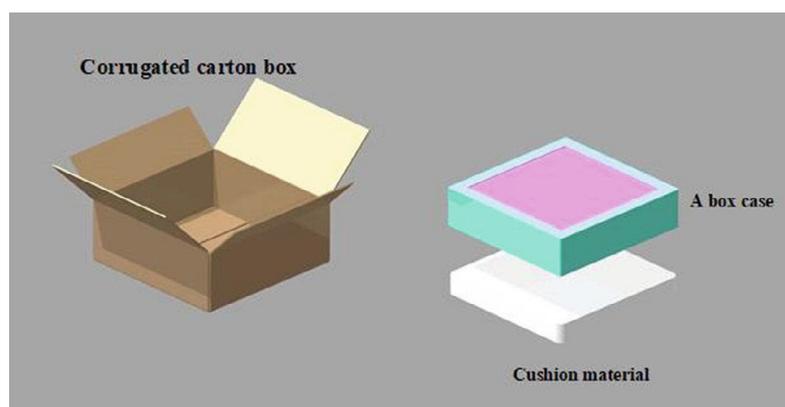


Fig. 1 A package consists of a product box and cushioning material [16]

Packaging design features emphasize the product's originality. A well-designed package attracts customers via brand communication [17]. Food packaging may be marketed by improving its qualities. Package features create branding uniqueness, attracting customers and influencing their purchases [3]. Different brand products have different package designs, features, and information, such as color design, that attract customers [18]. The role of packaging, reflecting the brand, material characteristics, and consumer psychology, has a direct impact on consumer purchases. Figure 2 shows several factors affecting consumer perception and purchase intention for different product packaging [19].

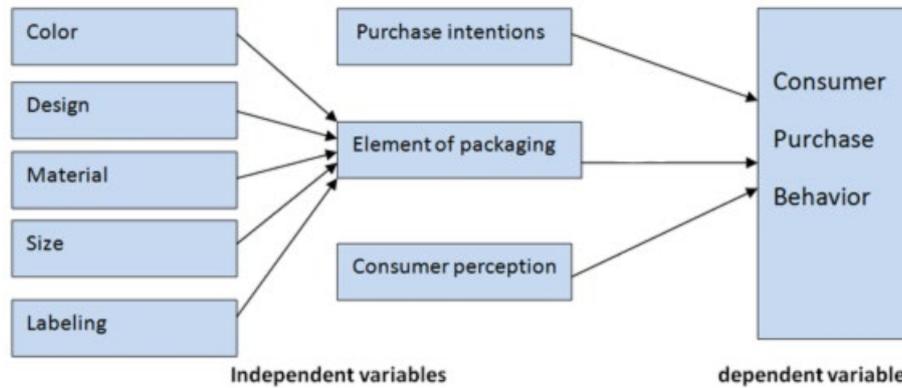


Fig. 2 Conceptual framework of consumer buying behavior [19]

Packaging information, often referred to as the label, must include the product name, net and total weight, manufacturing and expiry dates, storage conditions, manufacturer's address, and barcode. Packaging information is an essential element of the marketing mix, as it may boost advertising claims, develop brand identity, enhance name recognition, and optimize shelf space allocation [20]. Clear and accurate labeling also informs consumers about nutritional content, ingredients, and product origins, enhancing transparency and trust [21]. Labels act as a bridge between the product and the consumer, providing essential details that influence purchasing decisions and build brand credibility. Recent studies have highlighted that informative and visually appealing labels significantly impact consumer behavior, encouraging repeat purchases and fostering brand loyalty [22]. Proper labeling also ensures compliance with regulatory standards, contributing to product safety and marketability.

Table 1 shows that the Food Regulation 1985, amended by the Ministry of Health of Malaysia [23], includes a complete Food Labelling Guidelines checklist to ensure that all food packaging meets the norm. Such guidelines allow food manufacturers to ensure that packaging meets regulatory criteria, ensuring transparency and customer safety.

Table 1 Food labeling guidelines checklist

Elements	Description
i. Language	The label shall be in Malay or English.
ii. Logo	Display your approved brand logo on the front cover of your package and also other certifications valid in Malaysia with a reasonable size that is visibly seen.
iii. Description of the name of the food product	It should contain the common name of its principal ingredients. Product name will affect customer choice of buying to inform customers what the package contains.
iv. Ingredients labels	State all the contents in the food packaging. It should be labelled in descending order of proportion by weight, with the declaration of allergens.
v. Quantity of food in the package	It is mandatory to place the quantity of food either in net weight, volume, or number of contents.
vi. Information of the business company responsible for the packed food	Product of Malaysia, name and address of the manufacturer, and production of the food.
vii. Best before/expiration date	The date after which the food may not retain the quality attributes normally expected by the consumer under recommended storage conditions. Expressed in day, month, and year, or in month/year.

viii. Storage conditions	If the validity of the date marking of food is dependent on its storage, then the storage direction of that food shall also be required on its label.
ix. Nutrition labeling	Description of the nutrient content of the food.
x. Instructions.	Clearly state matters regarding temperature or instructions when opened for consumers to comprehend, or any optional/additional information.

2. Materials and Methods

Cushioning materials and corrugated board were used as raw materials. Figure 3 shows three cushioning types were utilized, including single-layer bubble wrap, double-layer bubble wrap, and inflatable air bubbles. These were used as a comparison in order to choose the best quality cushioning to ensure the protection and quality of the packaging during drop tests. Each lightweight option effectively protected the products from impact and minimized damage during transit.

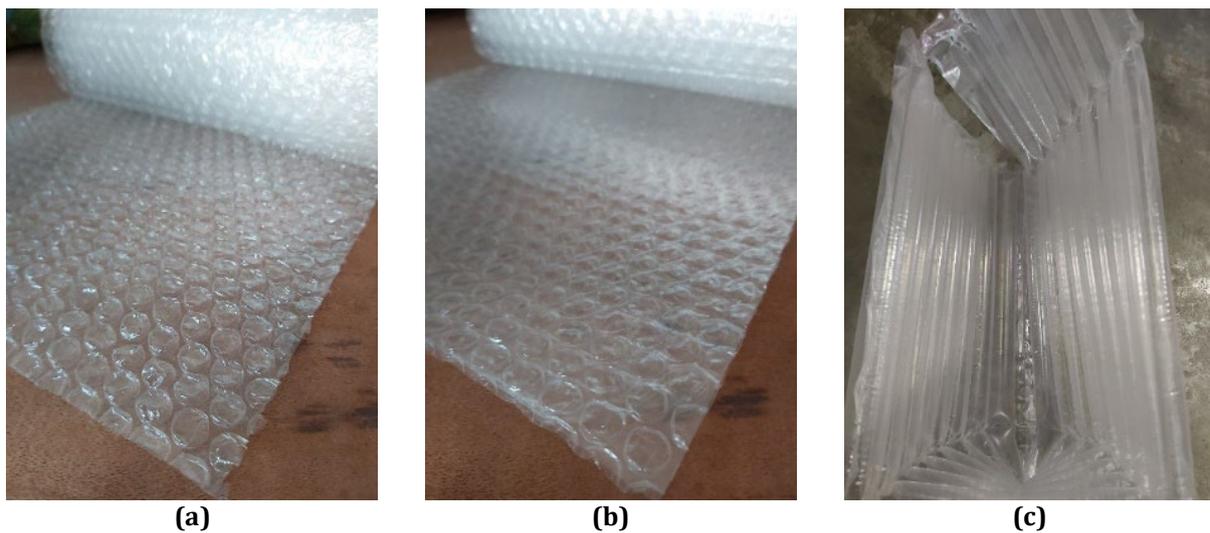


Fig. 3 Type of cushioning (a) Single-layer bubble wrap; (b) Double-layer bubble wrap; (c) Inflatable air bubble

A corrugated board E-flute single wall with a thickness of approximately 3mm is shown in Figure 4. A retort pouch measuring 15 cm x 20 cm is shown in Figure 5, designed with a stand-up feature, and was utilized for the packaging. The retort pouch was constructed to withstand high-temperature sterilization processes, capable of enduring conditions up to 121°C, ensuring the preservation of food quality and safety during processing. Additional tools included a stainless-steel ruler for precise measurements, a utility knife for clean and accurate cutting, and a cutting mat to ensure a safe and stable workspace during preparation.

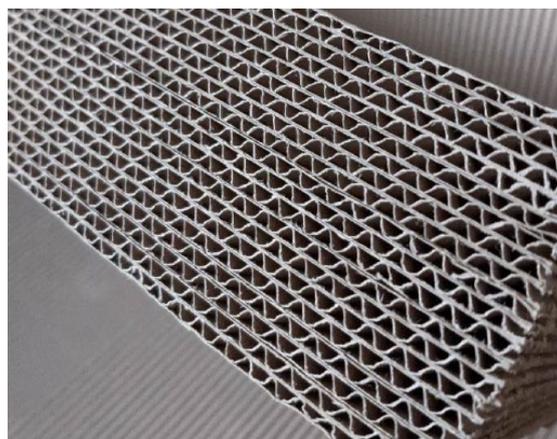


Fig. 4 Single-wall E-flute corrugated board



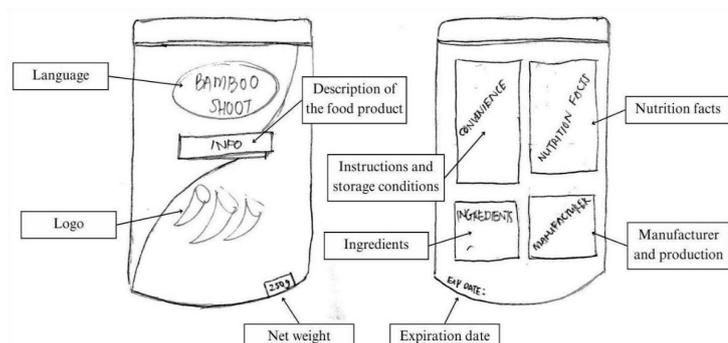
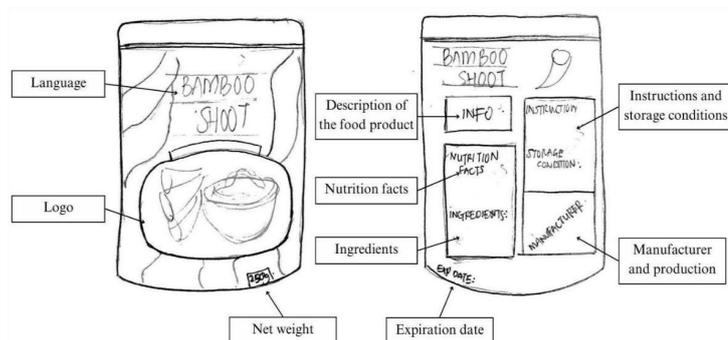
Fig. 5 Retort pouch (15cm x 20cm suitable for 250g to 500g)

2.1 Design Phase Development

The methodology followed a systematic design process comprising pre-design, design, and post-design phases. Each phase was structured to ensure the packaging design met both consumer and operational requirements.

1. Pre-Design Phase: Consumer Preferences

This phase involves identifying the objectives and the scope of the study and consumer survey. A consumer survey was conducted using a structured questionnaire to gather insights into consumer preferences for packaging dimensions, including visual appeal, size, and usability. This research targeted consumers in Parit Raja, Johor. The sample size represents the number of observations required to obtain valid and reliable data from the target population [24]. Based on a simplified sample size table developed by Krejcie and Morgan [25], 136 respondents were selected as the optimal sample size for this study [26]. This survey will utilize multiple-choice and multiple-response questions to quantify consumer perceptions of visual appeal, functionality, and overall satisfaction with the packaging designs [27]. Three distinct packaging designs were sketched. Some of the initial sketch ideas are being considered, as shown in Figure 6.



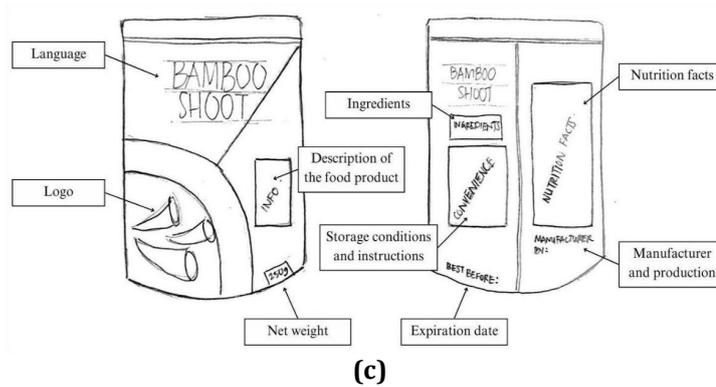


Fig. 6 Type of initial ideas and design (a) Illustrative design (b) Minimalist design (c) Eco-friendly design

2. Design Phase: Package Design

Package designs were developed using Adobe Photoshop and Pacdora software, incorporating consumer feedback. The package design should align with consumer preferences to enhance the purchasing experience. According to the Food Regulations 1985, amended by the Ministry of Health of Malaysia [23], there is a detailed checklist outlining the Food Labelling Guidelines, ensuring both legal requirements and consumer trust are met while boosting credibility [23].

3. Post-Design Phase: Drop Test

Packaging was developed and tested for durability, structural integrity, and alignment with consumer preferences. The scope of the experiment includes testing two types of food samples (bamboo shoot products), as shown in Figure 7:

- Sample A: Dry-textured bamboo shoot product (100g) with lower moisture content.
- Sample B: Wet-textured bamboo shoot product (100g) with higher moisture content.

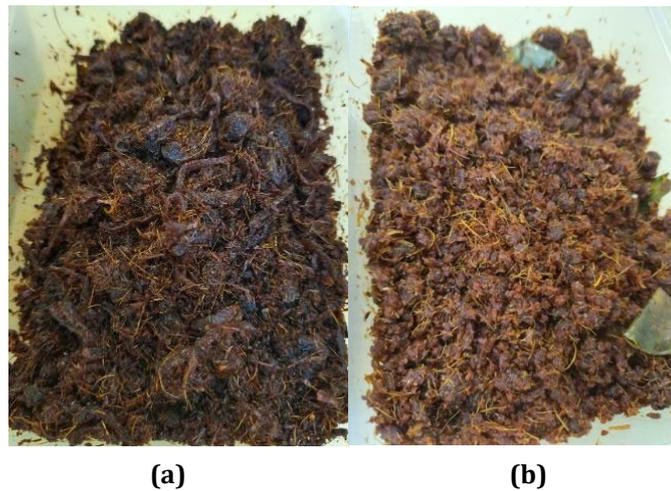


Fig. 7 The appearance of the bamboo shoot product (a) sample A; (b) sample B

The decision to choose a 100g quantity based on the food sample’s characteristics to ensure the retort pouch could accommodate the products without exceeding its capacity could compromise the pouch's structural integrity and the sterilization process, ultimately risking product spoilage and reducing shelf life. The combination drop test tested six package sample configurations for each food sample and cushioning type. Each drop position underwent three repetitions, resulting in 108 total drops. The G values recorded from the tests were averaged for further analysis.

2.1.1 Preparation of RFPs

The 100g packaging sizes ensured optimal sealing, reliable sterilization, and convenience for single-use portions or small servings, reducing waste and maintaining freshness. These smaller sizes also enhanced handling, storage, and transport efficiency, benefiting both producers and consumers while meeting retort process requirements. The retort process conducted a retort test using a retort machine (ZY-280, China), as shown in Figure 8, with 24 L capacity and 304 stainless steel, operated safely at 115°C–129°C and up to 0.17 MPa, ensuring consistent thermal treatment. Bamboo shoot products labelled Sample A and Sample B were placed in retort pouches for processing under stable conditions, maintaining quality, safety, and functionality.

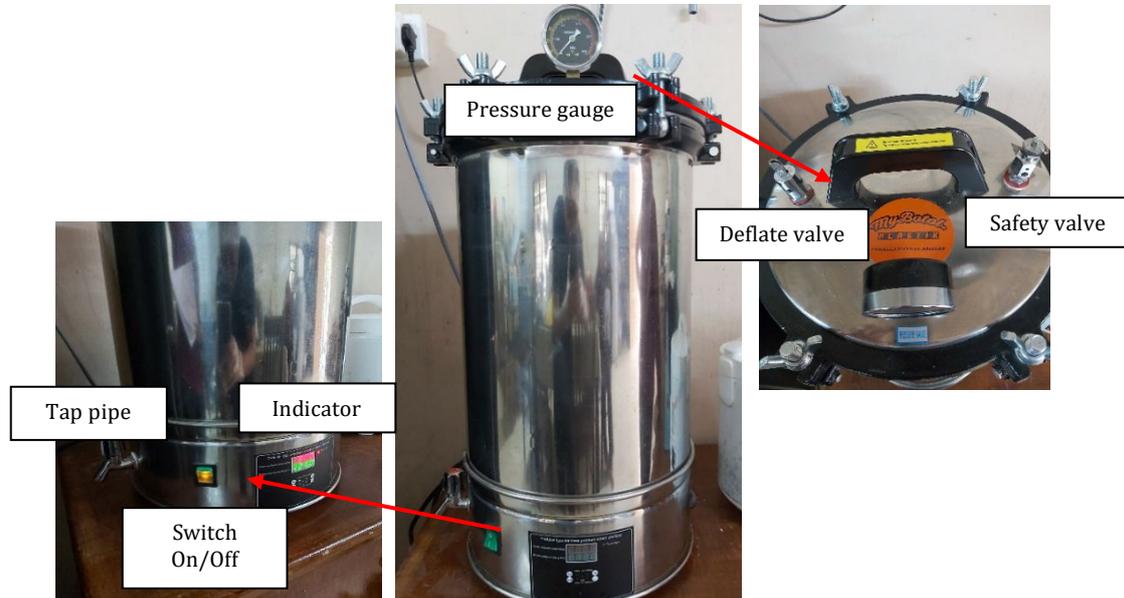


Fig. 8 Retort machine (ZY-280, China)

The retort packages were arranged in the machine in stages with spacing to ensure uniform exposure during processing. They were treated at 121°C (250°F) for 30 minutes, effectively eliminating harmful microorganisms while preserving the bamboo shoot product's flavor, texture, and nutrition. The RFP material, chosen for its thermal resistance, maintained structural integrity throughout the process.

2.1.2 Package Design and Sample Preparation for Drop Test

A gusset folder box made from E-flute corrugated board was designed that serves as a package to securely contain the RFPs, which were Sample A (dry-textured bamboo shoots) and Sample B (wet-textured bamboo shoots). Each sample was cushioned using single-layer bubble wrap, double-layer bubble wrap, or inflatable air bubbles. Dimensions of 25 × 18 × 8 cm were finalized to accommodate the RFPs efficiently. A gusset folder box was prepared with 108 boxes (package sample) allocated for the study. Figure 9 shows that the box was labeled with its designated impact angle to streamline the procedure and ensure consistent data collection. The structural design of the box provided adequate support for the RFPs, accommodating both the packaging and cushioning materials while maintaining the integrity of the test setup.



Fig. 9 Label on the gusset folder box

Cushioning materials, including single-layer bubble wrap, double-layer bubble wrap, and inflatable air bubbles, were applied to the pouches to provide added protection. These materials were selected to evaluate their effectiveness in minimizing damage during impacts and maintaining product integrity throughout the supply chain.

The drop tests adhered to the ASTM D5276 standard for free-fall testing of packages. Six drop positions were tested: top side, bottom side, left side, right side, left corner, and right corner. These positions were selected to simulate the various real-world impacts the packaging might encounter during handling and transportation. A total of 108 boxes were tested, each labeled with corresponding drop angles to ensure consistency and precision.

Each test involved placing the retort pouches, cushioned with the selected materials, into gusset folder boxes. Figure 10 shows that the drop height was 1.5 meters, representing a typical handling scenario during manual loading [28]. For each drop, the packaging was meticulously inspected for signs of damage, such as seal misalignment, flex cracks, or deformation. G-value readings were recorded using the data logger, MadgeTech Shock300, shown in Figure 11, to assess the impact resistance of the packaging and cushioning combinations.

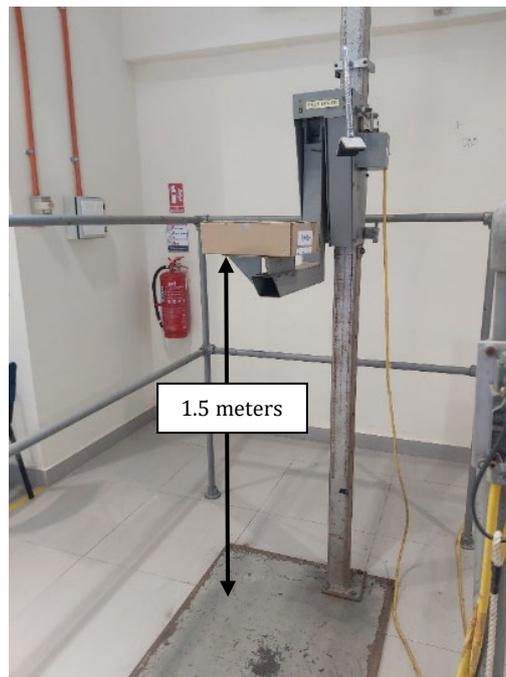


Fig. 10 Drop test machine (AD-100, USA)



Fig. 11 Data logger device (MadgeTech Shock300, USA)

Appropriate arrangements were made to prepare bamboo shoot product retort pouches for the drop test to ensure accurate data collection. Figure 12 shows how double-sided tape secured a data logger device to the pouch. It was essential to maintain the device in place throughout testing to capture impact forces accurately. The pouch and data logger were neatly wrapped in the cushioning after the attachment. Figure 13 shows the wrapping used, which included single-bubble wrap, double-layer bubble wrap, or inflated air bubbles. Figure 14 shows that clear tape sealed open edges to keep cushioning intact throughout testing.



Fig. 12 Attachment of the data logger device to the retort pouch

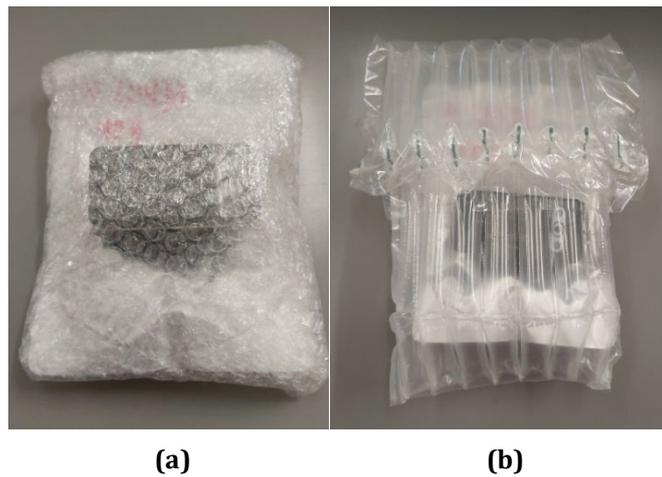


Fig. 13: Wrapping of retort pouch with selected cushioning (a) Bubble wrap; (b) Inflatable air bubble

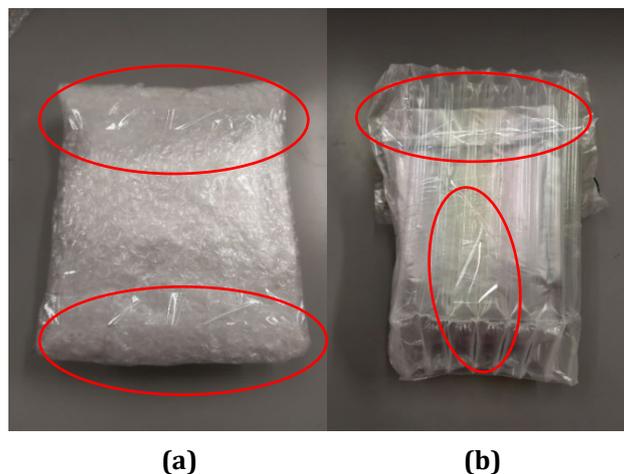


Fig. 14 Wrapping of retort pouch with selected cushioning (a) Bubble wrap; (b) Inflatable air bubble

Next, the wrapped pouch was carefully placed in the gusset folder box, as shown in Figure 15, positioned on the designated side as labeled in Figure 9. These labels indicated package drop position and angle, simplifying testing. Figure 16 shows the data logger above the pouch to ensure precise results. This design let the pouch absorb the complete drop while the data recorder precisely measured the forces. This systematic preparation provided reliable test results that reflected real-world handling conditions.



Fig. 15 Placement of wrapped retort pouch in the gusset folder box



(a)

(b)

Fig. 16 Positioning of the data logger device inside the gusset folder box (a) Bubble wrap; (b) Inflatable air bubble

Figure 17 shows the drop test on the top of the gusset folder box, which held a cushioned retort pouch. This design secured the pouch in the box, enabling the test to properly imitate real-world handling and transit impact forces.



Fig. 17 Topside undergoes the drop test

3. Results and Discussion

3.1 Pre-Design Phase: Consumer Preferences

The analysis of consumer preferences for bamboo shoot product packaging revealed distinct patterns. Among the 136 respondents, the gender distribution was balanced, with a slightly higher proportion of females (52.9%) than males (47.1%). Most participants (80.9%) were between 18 and 25 years old, emphasizing the dominance of younger consumers in the survey. The racial composition was predominantly Malay (91.9%), followed by Chinese and Indian respondents (2.9% each).

Regarding packaging design preferences, 38.2% of respondents favored Illustrative Design for its engaging visuals, followed by Eco-Friendly Design (36%) and Minimalist Design (25.7%). Additionally, 53.7% of respondents preferred imagery symbolizing freshness, such as green hues and dewdrop visuals, while 50% suggested incorporating bamboo leaves to highlight the product's natural origins [29]. Informative labeling was the preferred style (62.5%), indicating a consumer demand for clarity and transparency [30].

Medium-sized packaging (250-500 grams) was the most favored, with 66.9% of respondents selecting it due to its balance of convenience and practicality. In terms of color preferences, green (32.3%) emerged as the most enticing, followed by yellow (21%) and white (15.8%), reflecting an association with freshness and simplicity [31].

3.2 Design Phase: Package Design

The insights gathered from the survey were instrumental in developing packaging tailored to consumer preferences. Figure 16 shows the final designs incorporating green, yellow, and white hues to convey freshness and eco-friendliness, with visuals symbolizing natural origins. Informative labeling was integrated to provide transparency, aligning with consumer demands for clarity. Medium-sized retort pouches were chosen to enhance convenience and practicality for the target demographic.



Fig. 18 Design of the retortable flexible pouch for bamboo shoot product

Based on Figure 18, the label design for the bamboo shoot product packaging is bilingual, with text centrally positioned for easy readability. The product name, SerunBung, is prominently displayed at the upper center of the design, accompanied by the tagline, *Tradisi Rasa dalam Gigitan Modern*, located just below it. A circular logo featuring Tunas Rebung Co., UTHM is placed at the top center to emphasize brand identity.

The ingredients list, including bamboo shoots, coconut milk, spices, salt, and sugar, is located in the upper right quadrant of the packaging, while the preparation and consumption instructions, such as Ready to Eat and heating guidelines, are positioned just below the ingredients list. The storage conditions, instructing consumers to store the product in a cool and dry place, are also located in this section, ensuring cohesive and accessible information.

The bottom right quadrant contains essential details, including the food quantity (100g), the manufacturing and expiration dates (MFG and EXP), and the manufacturer's information, which reads Manufactured by: Tunas Rebung Co., Johor, Malaysia. The nutrition facts table is also situated in this area to provide clear dietary information to consumers.

Importantly, all elements of this label design are aligned with the Food Labelling Guidelines checklist, as amended by the Ministry of Health of Malaysia in 2023 [23]. This ensures compliance with legal standards,

enhances transparency, and builds consumer trust by providing clear, accurate, and accessible information in a visually appealing and functional manner.

3.3 Post-Design Phase: Drop Test Results

Table 2 and Table 3 show the drop test results for retort pouches containing bamboo shoot products, which were wrapped with three different cushioning materials, including single-layer bubble wrap, double-layer bubble wrap, and inflatable air bubbles. Six drop positions are on the top side, bottom side, left corner side, right corner side, left side, and right side. Samples A and B were tested for two product types, as detailed in Section 2.1. G-values were recorded to assess impact resistance. This method aligns with research highlighting the necessity of evaluating packaging materials under various drop scenarios to determine their protective capabilities [31].

Table 2 Drop test result for sample A

Cushioning	Top side	Bottom side	Left corner side	Right corner side	Left side	Right side
Single-layer bubble wrap	364.4	269.1	155.1	118.7	155.0	122.0
Double-layer bubble wrap	121.0	227.6	113.0	58.4	94.8	102.6
Inflatable air bubble	46.0	93.1	28.0	54.9	85.2	29.8

Table 3 Drop test result for sample B

Cushioning	Top side	Bottom side	Left corner side	Right corner side	Left side	Right side
Single-layer bubble wrap	358.2	255.7	128.6	122.1	182.0	120.0
Double-layer bubble wrap	143.7	144.4	62.5	35.4	81.5	100.5
Inflatable air bubble	86.0	72.4	41.6	29.6	58.9	39.0

The results of the drop tests highlighted clear trends in cushioning performance across different types of packaging and product textures, as illustrated in the radar chart below. For Sample A, as shown in Figure 19, the highest G-value (364.4 G) was observed with single-layer bubble wrap during the top-side drop, indicating limited shock absorption. Inflatable air bubbles exhibited superior performance, with the lowest G-values recorded at 28.0 G (left corner) and 29.8 G (right side), effectively mitigating impact forces [32]. Double-layer bubble wrap provided moderate protection, with G-values ranging from 58.9 G to 227.6 G.

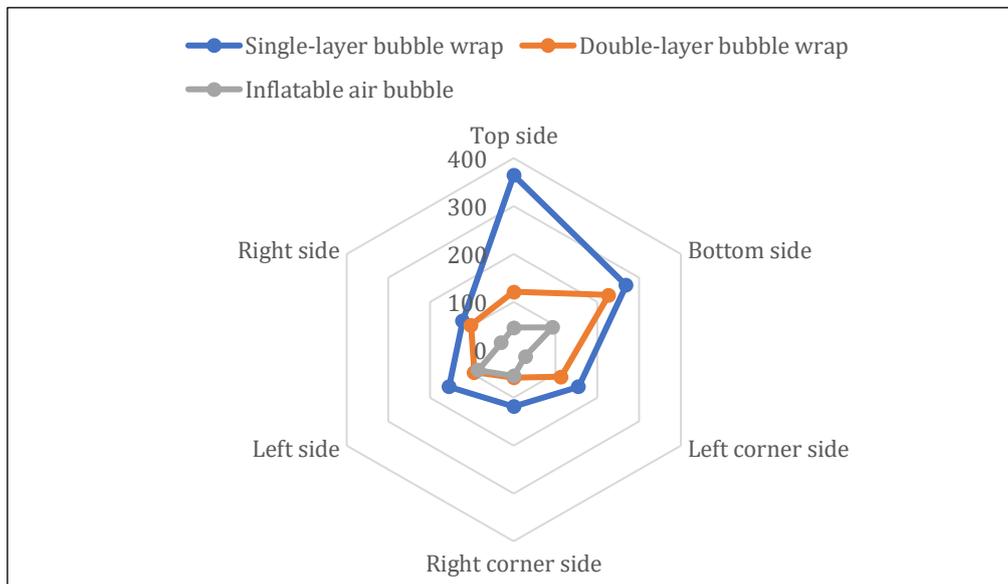


Fig. 19 The dry textured bamboo shoot products (Sample A)

As shown in Figure 20, Sample B exhibited similar trends, with the highest G-value (358.2 G) recorded for single-layer bubble wrap during the top-side drop. Inflatable air bubbles again outperformed other materials, achieving the lowest G-values of 29.6 G (right corner) and 39.0 G (right side). Double-layer bubble wrap provided intermediate protection, with G-values ranging from 35.4 G to 143.7 G, demonstrating better performance than single-layer bubble wrap but not as effective as inflatable air bubbles [33].

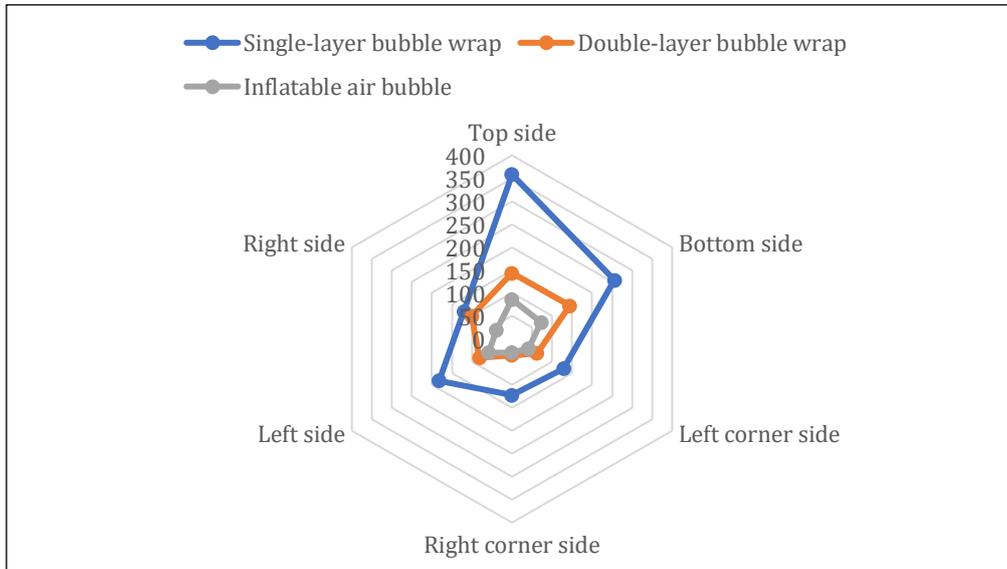


Fig. 20 The wet textured bamboo shoot products (Sample B)

As shown in Figure 21, the drop test results highlight the impact of insufficient cushioning for dry-textured bamboo shoots using single-layer bubble wrap. After the drop test was performed, the corrugated box showed visible edge and center damage, indicating inadequate shock absorption by the cushioning. This contributes to the need for more effective materials to ensure better protection during transport [34].

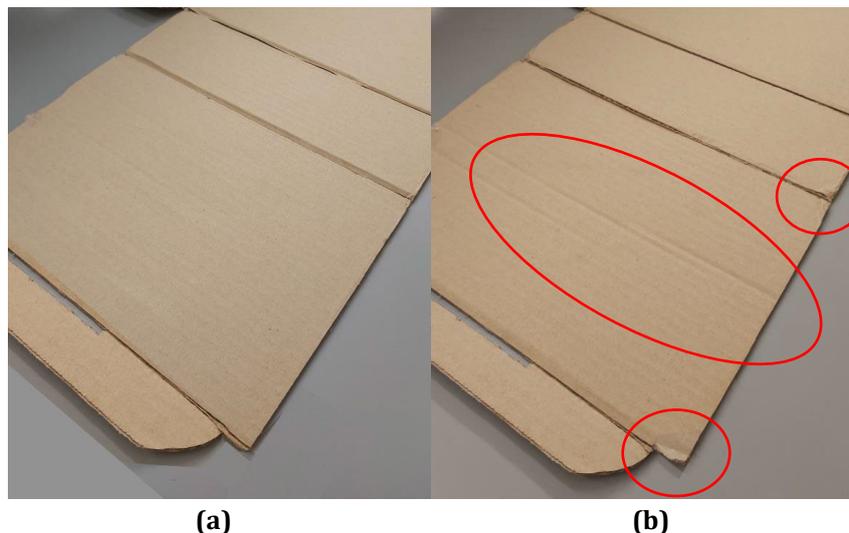


Fig. 21 Condition of the corrugated box (a) before the drop test; (b) after the drop test

The results highlighted the critical role of cushioning materials in ensuring product safety. Inflatable air bubbles consistently demonstrated the highest effectiveness, maintaining structural integrity across all drop positions [35]. Single-layer bubble wrap proved insufficient for delicate or impact-sensitive products, while double-layer bubble wrap provided improved but still suboptimal performance.

Drop test findings demonstrated the importance of selecting effective cushioning materials. Inflatable air bubbles emerged as the most reliable solution, minimizing impact forces and preserving product integrity [36].

These insights are crucial for optimizing packaging strategies to enhance safety and reliability during transportation and handling. Sample A, with its dry and compact texture, transferred more force upon impact, resulting in higher G values. Conversely, Sample B, characterized by a wet and pliable texture, exhibited greater shock absorption, leading to lower G values in certain scenarios. For instance, in the topside drop test using single-layer bubble wrap, Sample A recorded a G value of 364.4, slightly higher than Sample B's 356.2. However, with double-layer bubble wrap, Sample A's G value decreased to 121.0, significantly lower than Sample B's 143.7.

While the samples' physical characteristics influenced their impact responses, their radar chart patterns were nearly identical, suggesting similar trends under varying testing conditions [37]. These findings highlight the importance of tailoring cushioning materials to product-specific attributes to ensure optimal protection during transit. These differences in cushioning performance can be attributed to material science principles. Inflatable air bubbles compress upon impact, dissipating force more effectively than bubble wrap, while their flexibility allows for better force distribution, reducing localized stress. Double-layer bubble wrap exhibited moderate resilience, reducing impact forces but not as efficiently as inflatable air bubbles [38].

4. Conclusion

This study successfully achieved its aim of assessing the durability of Retortable Flexible Pouches (RFPs) through performance drop tests. By evaluating consumer preferences and incorporating their insights into the packaging design, the research ensured functional, aesthetic, and structural suitability for bamboo shoot products. Drop test results highlighted the critical role of cushioning materials in maintaining product integrity under impact conditions. Inflatable air bubbles consistently demonstrated superior performance, achieving the lowest G values and providing the most effective shock absorption compared to single-layer and double-layer bubble wraps. For instance, the highest G value recorded for Sample A was 364.4 G (top side, single-layer bubble wrap), while the lowest was 28 G (right corner, inflatable air bubbles). Similarly, for Sample B, the highest G value was 358.2 G, with the lowest at 29.6 G under the same conditions. These findings emphasize the importance of selecting appropriate cushioning materials to ensure product safety. This research establishes a robust framework for developing effective RFP solutions, paving the way for future advancements in bamboo shoot product packaging. Further research can explore extended environmental testing, such as temperature and humidity variations, to assess packaging performance under different storage and transportation conditions. Long-term durability studies can provide insights into the structural integrity of RFPs over time. A comparative analysis with alternative packaging materials may help identify more sustainable or cost-effective options. Additionally, an economic cost-benefit analysis of different cushioning approaches could optimize packaging design while maintaining affordability and protection efficiency.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm their contribution to the paper as follows: **study conception and design:** Muhammad Fareez Ahaddon, Nor Mazlana Main; **data collection:** Muhammad Fareez Ahaddon; **analysis and interpretation of results:** Muhammad Fareez Ahaddon, Nor Mazlana Main, Shaiful Rizal Masrol; **draft manuscript preparation:** Muhammad Fareez Ahaddon, Nor Mazlana Main, Mohd Faizal Esa. All authors reviewed the results and approved the final version of the manuscript.

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