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Research Article

A Sustainable Dishwashing Paste Using Coconut Husk Ash for Cleaning Efficiency, Perceived Antibacterial Effectiveness, and User Acceptability

Mario B. Pardillo [1], Ve Leslie Atanoza [1], Aizamie Angcon [1], Jane Marie Hayag [1], Rica Palomas [1,*], and Joan Travero [1]

[1] Technology Management Department, College of Technology, Cebu Technological University, Philippines
* Correspondence: palomasricaroselim@gmail.com

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Abstract: The growing demand for sustainable household products highlights the need for cleaning solutions that balance functional performance, consumer acceptance, and economic feasibility. This study evaluates EcoScent Dishwashing Paste, a dishwashing formulation incorporating coconut husk ash as a value-adding agricultural by-product, with emphasis on user acceptability and cost feasibility as indicators of potential market adoption. An experimental and descriptive research design was employed, involving user-based testing under normal household and small-scale food service conditions. Data were collected from 50 respondents through structured surveys assessing perceived cleaning efficiency, sensory attributes, skin-friendliness, and perceived antibacterial effectiveness. Results indicate that the dishwashing paste demonstrated satisfactory cleaning performance and was generally well accepted in terms of ease of use, scent, and overall user experience. A cost analysis further suggests that the product can be produced at a relatively low unit cost, supporting its feasibility for small-scale or community-based production. From a sustainability and management perspective, the utilization of coconut husk ash supports circular economy principles by converting agricultural waste into a functional household product. Overall, the findings suggest that coconut husk ash–based dishwashing paste has potential as a sustainable and economically viable alternative within the household cleaning market.

Keywords: coconut husk ash; economic feasibility; user acceptability; sustainable products; household cleaning

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1. Introduction

Household dishwashing products are essential for maintaining sanitation in domestic and small-scale food service settings. However, many commercially available dishwashing pastes rely heavily on synthetic surfactants, chemical builders, and artificial fragrances that have been associated with skin irritation and environmental concerns. Previous studies have reported that prolonged exposure to certain dishwashing chemicals may contribute to skin dryness and discomfort, while detergent residues released into wastewater systems can negatively affect aquatic ecosystems (Vanguardia, 2023). These concerns have increased interest in sustainable household cleaning products that reduce environmental impact while maintaining functional performance.

Recent research highlights the potential of utilizing natural materials and agricultural by-products in household product formulations. Coconut husk ash, a by-product of coconut processing, has been identified as a functional material due to its mild abrasive properties and alkaline characteristics, which can support grease removal and surface cleaning (Antonini et al., 2024). From a sustainability and resource management perspective, the use of coconut husk ash aligns with circular economy principles by converting locally abundant biomass waste into value-adding products, thereby reducing waste and dependence on purely synthetic inputs (Mamun et al., 2023).

Beyond technical performance, consumer acceptance and economic feasibility play a

critical role in determining whether sustainable household products can be successfully adopted and commercialized. Studies on household product consumption emphasize that user perceptions of cleaning efficiency, scent, texture, skin-friendliness, and overall usability strongly influence purchasing decisions and continued product use (Baek & Kim, 2022). These factors are particularly relevant for small-scale or community-based production initiatives, where affordability, accessibility of raw materials, and user satisfaction directly affect market viability.

Despite growing interest in eco-friendly cleaning solutions, limited empirical research has examined dishwashing paste formulations that integrate coconut husk ash while simultaneously evaluating user acceptability and cost feasibility under real-use conditions. Addressing this gap, the present study aims to evaluate EcoScent Dishwashing Paste, a dishwashing formulation incorporating coconut husk ash, with emphasis on perceived cleaning performance, user acceptability, and economic feasibility as indicators of potential market adoption. By linking product performance with consumer perception and cost considerations, this study contributes to economics and management discussions on sustainable product development, household consumption behavior, and the practical application of circular economy principles in everyday consumer goods.

2. Materials and Methods

This study employed an experimental and descriptive research design to evaluate the user acceptability and economic feasibility of EcoScent Dishwashing Paste, a sustainable household cleaning product formulated using coconut husk ash. The methodological approach focused on (1) developing a dishwashing paste suitable for small-scale production, and (2) assessing product performance and consumer perception under real-use conditions as indicators of potential market adoption.

2.1. Materials

The EcoScent Dishwashing Paste was formulated to produce approximately 3 kg of finished product, equivalent to 15 containers of 200 g each, reflecting a scale applicable to community-based or small-enterprise production. The materials used included a premixed degreasing agent (500 g), soda ash or sodium carbonate (500 g), cleaning agent (1 kg), coconut husk ash, antibacterial cleaning agent, hardener (20 mL), colorant, and lavender mint fragrance. All materials were sourced from local suppliers to support accessibility and cost efficiency.

Coconut husk ash was prepared by burning dried coconut husks and grinding the resulting ash into a fine powder. The ash served as a mild abrasive and sustainability-enhancing component, contributing to grease removal while supporting the utilization of agricultural waste. The lavender mint fragrance was incorporated to improve sensory acceptability and odor reduction, factors that influence consumer preference and product adoption.

2.2. Formulation Procedure

An exploratory formulation process was conducted to achieve a stable and usable dishwashing paste prior to user evaluation. The premixed degreasing agent and soda ash were first combined and mixed thoroughly to establish the cleaning base. Coconut husk ash was then added gradually to ensure even distribution of the abrasive component. The cleaning agent, colorant, antibacterial cleaning agent, and hardener were subsequently incorporated and mixed until a uniform paste consistency was achieved. Finally, the lavender mint fragrance was added to enhance user experience. Product formulation and preparation is shown in appendix B.

The completed paste was transferred into 200 g plastic containers and allowed to rest for 24 hours to stabilize texture and consistency. Due to the exploratory nature of formulation trials and the absence of quantitative comparisons among intermediate mixtures, only the final optimized formulation was selected for user-based evaluation.

2.3. User-Based Evaluation and Data Collection

User-based testing served as the primary evaluation method, reflecting real-use conditions relevant to consumer adoption. A total of 50 respondents participated in the study, selected through purposive sampling. Participants included homemakers, food vendors, and community members who regularly perform dishwashing activities.

Each respondent received a 200 g container of the dishwashing paste and was instructed

to use the product during their normal dishwashing routine over several days. Following the usage period, data were collected through a structured survey administered via Google Forms. The survey included demographic items, Likert-scale questions assessing perceived cleaning efficiency, sensory attributes, skin-friendliness, and perceived antibacterial effectiveness, as well as open-ended questions for qualitative feedback. Appendix A presents EcoScent Dishwashing survey instrument.

2.4. Data Analysis and Ethical Considerations

Quantitative data were analyzed using descriptive statistics, including frequencies, percentages, and mean scores, to summarize user evaluations. Qualitative responses were analyzed using thematic analysis to identify recurring perceptions related to usability and product acceptability. All analyses were conducted using Microsoft Excel.

The study involved a non-invasive user survey and did not collect sensitive personal data. Ethical review and approval were not required. Informed consent was obtained from all participants prior to their participation

3. Results

This section presents the results of the user-based evaluation of EcoScent Dishwashing Paste, focusing on respondent characteristics, perceived product performance, user acceptability, adoption indicators, and economic feasibility. Results are organized into subsections and supported by tables and figures.

3.1. Respondent Profile

A total of 50 respondents participated in the survey. Table 1 shows respondents profile summary as well as figure 1 demonstrates respondents profile distribution. The respondents consisted of homemakers, food vendors, and community members who regularly perform dishwashing activities. This composition ensured that feedback was gathered from users with varying levels of dishwashing frequency and exposure.

Table 1. Respondents profile summary (n=50).

Category	Description
Type of Respondents	Homemakers, food vendors, community members
Dishwashing Frequency	Regular to frequent dishwashing
Product Exposure	First-time and short-term use of EcoScent Dishwashing Paste

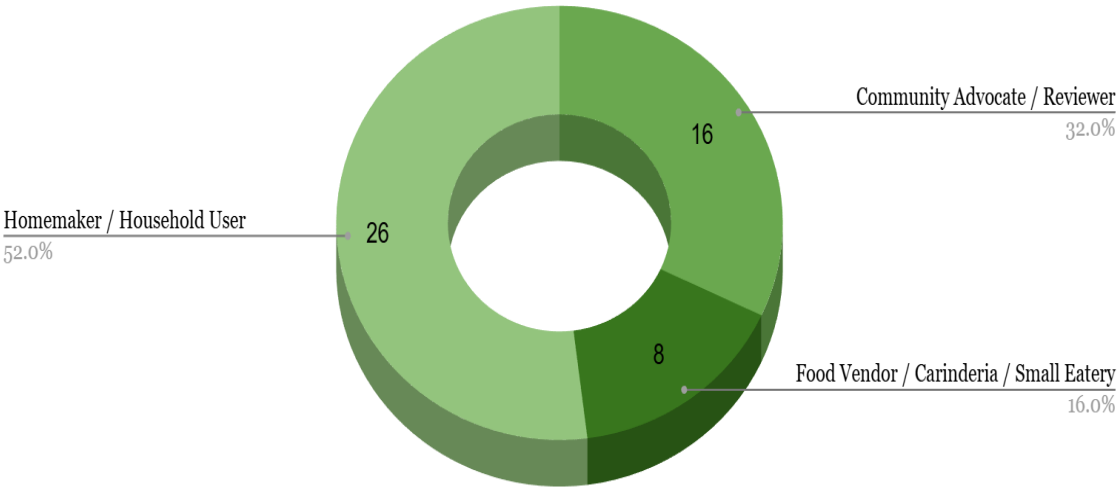

Figure 1. Respondents profile distribution.

3.2. Perceived Cleaning Performance

Respondents evaluated the cleaning performance of EcoScent Dishwashing Paste in terms of grease removal, ease of washing, foaming behavior, and ease of rinsing. Overall, the results indicate positive user perception of cleaning effectiveness. Most respondents agreed

that the product effectively removed grease and food residues from dishes.

Adequate foam production was commonly associated with effective cleaning, while ease of rinsing was rated favorably, suggesting that the paste did not leave excessive residue on dishware. These findings indicate that the formulation met functional performance expectations under normal dishwashing conditions. Table 2 gives the summary of perceived cleaning performance. At the same time, figure 2 provides the information about perceived cleaning performance of EcoScent Dishwashing Paste.

Table 2. Summary of perceived cleaning performance.

Indicator	General survey outcome
Grease removal	Rated positively by most respondents
Foaming behavior	Adequateland acceptable
Ease of rinsing	Generally satisfactory

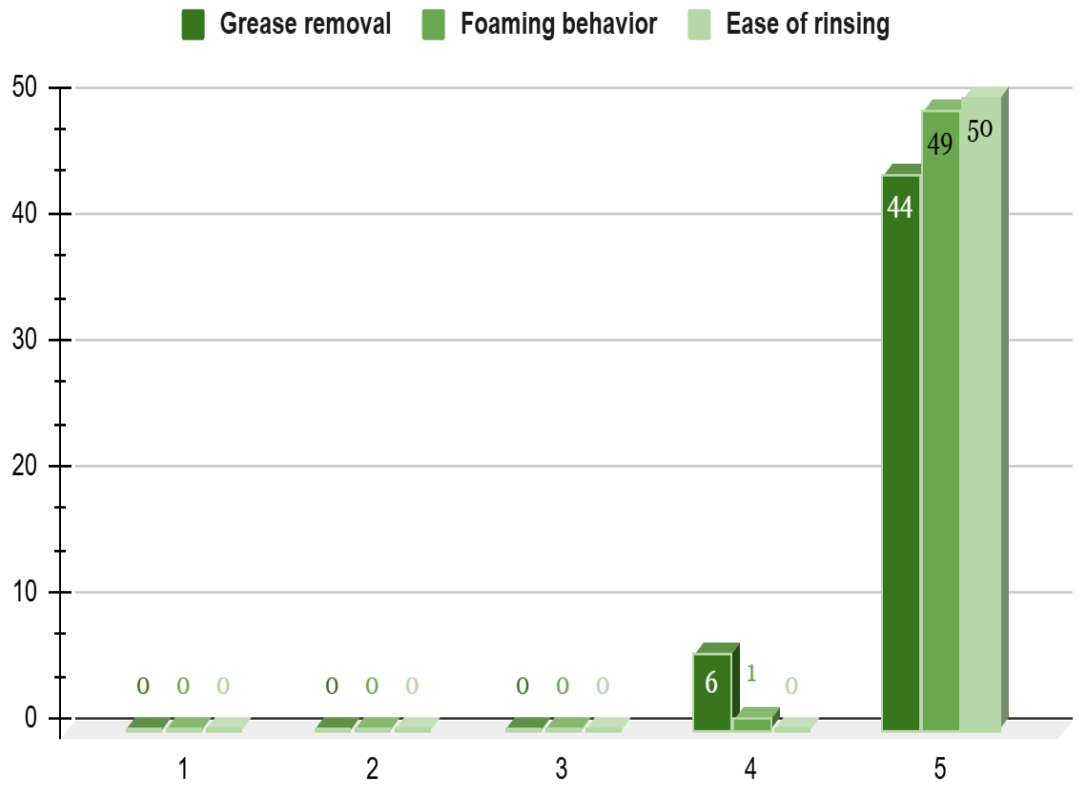

Figure 2. Perceived cleaning performance of EcoScent Dishwashing Paste.

3.3. Sensory Attributes: Scent, Texture, and Appearance

The sensory characteristics of the dishwashing paste were evaluated as part of overall user acceptability. The lavender mint scent was generally described as pleasant and not overpowering. Respondents reported that the paste texture was manageable, allowing easy scooping and application during dishwashing. The appearance of the product was also rated as acceptable by most users.

Although overall feedback was positive, a small number of respondents suggested that minor adjustments to paste consistency could further improve usability during prolonged use. Sensory evaluation results are summarized in Table 3 and Figure 3.

Table 3. Sensory attribute evaluation.

Attribute	User response summary
Scent acceptability	Pleasant and acceptable
Texture	Generally manageable
Appearance	Visually acceptable

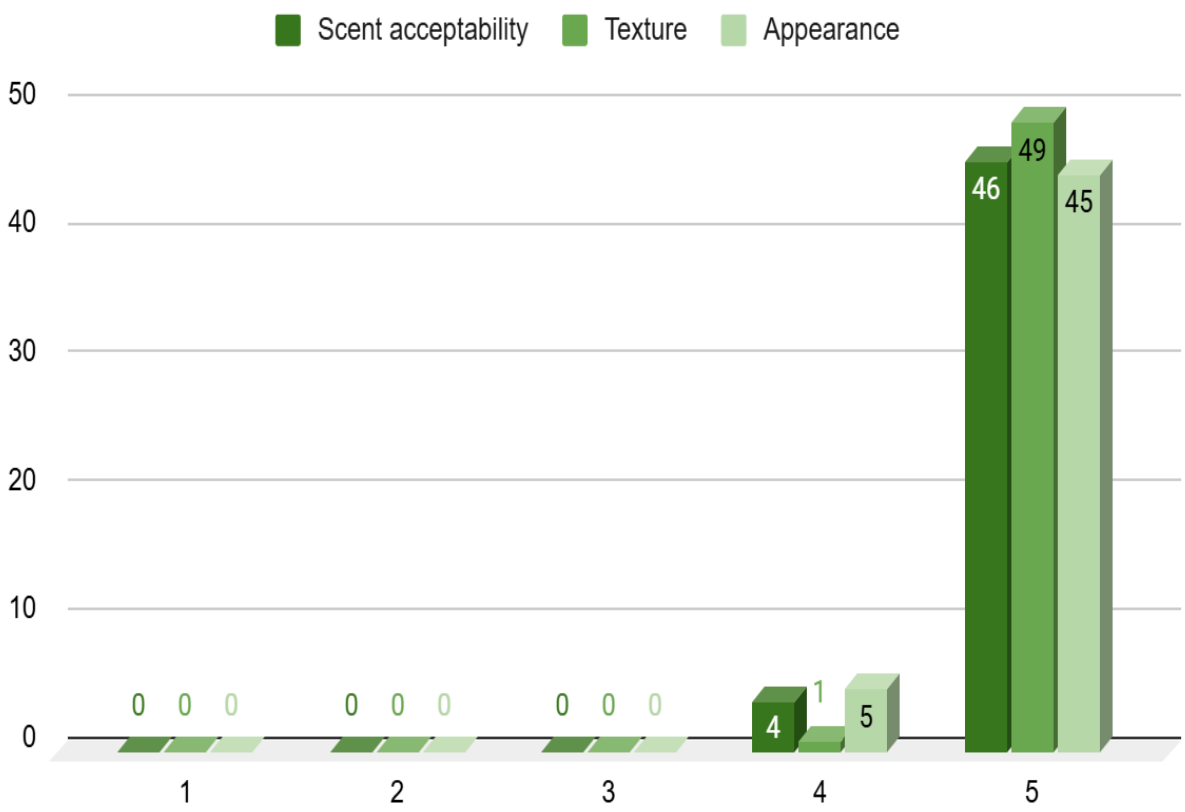

Figure 3. Sensory attributes: scent, texture, and appearance.

3.4. Skin-Friendliness and Perceived Antibacterial Effectiveness

With respect to skin response, the majority of respondents reported no itching, redness, or irritation during product use. A limited number of respondents noted mild and temporary skin dryness or peeling, particularly after extended dishwashing sessions. These effects were not associated with pain or discomfort and were reported as manageable.

Perceived antibacterial effectiveness was evaluated based on users' assessment of cleanliness and odor reduction after washing. Most respondents perceived the product as hygienic and suitable for daily dishwashing needs. These findings reflect user confidence in the product's cleaning and odor-reducing performance based on subjective evaluation rather than laboratory testing. In the article, skin response and perceived antibacterial effectiveness are analysed in Table 4 and Figure 4.

Table 4. Skin response and perceived antibacterial effectiveness.

Indicator	Survey observation
Skin reaction	Mostly no adverse reaction
Reported dryness/peeling	Minor and limited
Perceived antibacterial effectiveness	Generally positive

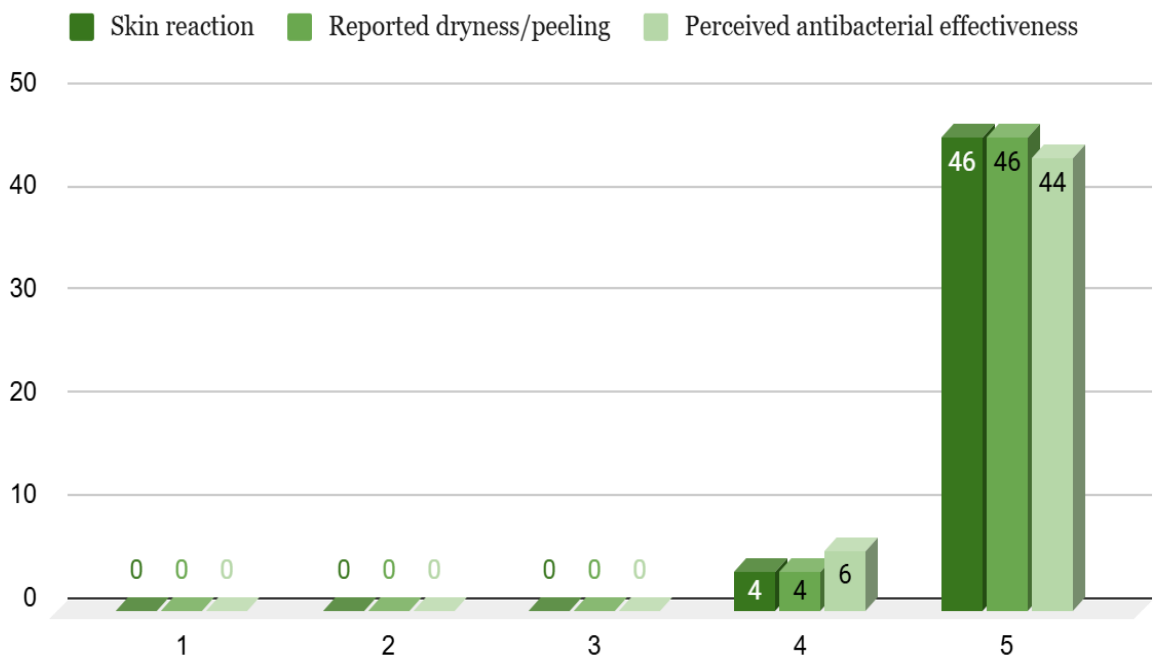

Figure 4. Skin response and perceived antibacterial effectiveness.

3.5. Acceptability and Adoption Indicators

Overall user satisfaction with EcoScent Dishwashing Paste was rated positively. Most respondents indicated that they were satisfied with the product's performance and expressed willingness to use the dishwashing paste on a regular basis. Respondents also reported that the product was suitable for both household dishwashing and small-scale food service applications.

Notably, a majority of respondents indicated that they would consider switching to the product if it were available in the market. These responses suggest favorable adoption potential, with user acceptability serving as an indicator of potential market readiness.

3.6. Cost Analysis and Economic Feasibility

A cost analysis was conducted to estimate the production cost of EcoScent Dishwashing Paste under small-scale production conditions. The formulation yielded approximately 3 kg of finished product, equivalent to 15 containers of 200 g each. The cost analysis is presented at a summary level to highlight key cost components and assess feasibility for small-scale production, rather than to provide a detailed commercial costing.

Table 5. Cost breakdown of Ecoscent Dishwashing Paste production.

Cost Component	Amount (₱)
Base Ingredients (e.g. Soda, Degreasing Agent, colorant..)	270.00
Coconut Husk Ash	13.50
Fragnance (e.g. Lavender mint)	33.81
Packaging (15 containers)	90.00
Labor (30mins)	50.00
Total Production Cost	457.31
Estimated Cost per 200g container	₱ 30.50

The results indicate that coconut husk ash contributes minimally to overall production cost, highlighting its suitability as a low-cost, value-adding input derived from agricultural waste. The estimated unit cost suggests that the product may be economically feasible for small-scale or community-based production, particularly in coconut-producing areas where raw materials are readily available.

4. Discussion

The results of this study align with broader findings on consumer perceptions of sustainable products, which indicate that positive attitudes toward eco-friendly alternatives do not always translate into widespread market adoption. For example, although many consumers express favorable views of sustainable consumption, actual market share for such products remains low due to complex decision-making processes involving perceived value, price, and habit (Gandhi et al., 2023; Camilleri et al., 2023).

The emphasis on user acceptability in the present study resonates with research on sustainable consumer behavior that underscores the importance of attitudes, subjective norms, and perceived behavioral control in shaping product adoption (Syed et al., 2024). Studies based on the Theory of Planned Behavior have shown that internal motivations and external influences significantly affect individuals' intentions to adopt sustainable products (Naskar & Lindahl, 2025).

Eco-efficiency assessments in related product categories, such as dishwashing detergents, support the notion that integrating environmental and economic performance can guide decision-making for both producers and consumers. Research on eco-efficiency profiling of cleaning agents suggests that life cycle and environmental considerations can influence product development and consumer preferences (Majid et al., 2023).

The use of agricultural by-products, such as coconut husk ash, aligns with broader sustainability strategies that valorize biomass waste. While most research on coconut by-products focuses on applications in packaging or soil amendments, these studies highlight the potential of coconut waste as a resource for value-added products within circular economy frameworks (Özkan Karabacak et al., 2024).

Consumer perceptions of green cleaning products also reflect broader trends in sustainable product adoption. Research indicates that consumers often struggle to identify green products, yet those who correctly recognize them perceive them as safer and more environmentally friendly, supporting the relevance of sensory attributes and product cues in purchase decisions (Szymandera-Buszka et al., 2025).

The findings in this study regarding user acceptability also mirror insights from consumer behavior research in household cleaning contexts, where functionality and perceived effectiveness remain primary drivers of product choice, even among those interested in natural or sustainable alternatives (Geetha & Tyagi, 2016).

The economic dimension of sustainable product adoption is underscored by broader consumer insights. For example, global consumer research shows that while there is growing demand for sustainable goods, cost considerations (i.e., "green premiums") can constrain purchases, particularly in discretionary categories including household products (Gausden & Hasan, 2025).

Studies on sustainable consumer behavior further explain that product attributes, including environmental benefits and price, interact with consumer decision-making, emphasizing the need to balance value perceptions with sustainability claims (Bocken et al., 2019).

These comparisons indicate that your findings – highlighting positive user acceptability alongside cost feasibility – are consistent with broader patterns in sustainable product research, where product performance, cost considerations, and consumer perceptions jointly influence adoption potential. They also suggest that household cleaning products incorporating waste-derived inputs can align with sustainability expectations while addressing economic feasibility, positioning them within the competitive landscape of eco-friendly alternatives.

5. Conclusions

This study evaluated EcoScent Dishwashing Paste, a sustainable household cleaning product incorporating coconut husk ash, with emphasis on user acceptability and economic feasibility as indicators of potential market adoption. The findings indicate that the product demonstrated satisfactory cleaning performance and was generally well accepted by users in terms of sensory attributes, skin-friendliness, and overall usability under normal household and small-scale food service conditions.

The cost analysis suggests that the dishwashing paste can be produced at a relatively low unit cost under small-scale production settings, supporting its feasibility for community-based or micro-enterprise applications. The minimal cost contribution of coconut husk ash

highlights its value as a functional, low-cost input derived from agricultural waste.

From an economic and management perspective, the integration of coconut husk ash reflects circular economy principles by transforming locally available biomass waste into a value-adding household product. User acceptability and reported adoption intention further suggest that the product has potential as a sustainable alternative within the household cleaning market.

Overall, the study demonstrates that coconut husk ash–based dishwashing paste can support both sustainability objectives and practical market considerations. Future research may further examine scalability, long-term usability, and comparative market performance to strengthen understanding of its commercialization potential.

Supplementary Materials & Data Availability Statement: The survey questionnaire and anonymized dataset generated during this study are available from the corresponding author upon reasonable request. The dataset does not contain any personal identifying information and is provided solely for academic verification and research purposes.

Author Contributions: Conceptualization, A.A. and J.M.H.; methodology, A.A. and R.P.; product formulation and data collection, A.A., J.M.H., and J.T.; data analysis, R.P. and J.M.H.; writing, original draft preparation, J.T.; writing, review and editing, J.M.H. and R.P. All authors have read and approved the final version of the manuscript.

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Institutional Review Board Statement: Ethical review and approval were not required for this study, as it involved a non-invasive survey on household dishwashing product use and did not collect sensitive personal data.

Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

EcoScent Dishwashing Survey Instrument

EcoScent Dishwashing Survey Questionnaire

Instructions:
Please answer the following questions based on your experience using the EcoScent Dishwashing Paste. Your responses will be used for academic research purposes only. All answers will be kept confidential.

I. Respondent Profile

AGE: ☐ Below 18 ☐ 18–25 ☐ 26–35 ☐ 36–45 ☐ 46 and above

Gender: ☐ Male ☐ Female ☐ Prefer not to say

Primary Role: ☐ Homemaker ☐ Food vendor / small food business worker
☐ Community member ☐ Other: _____

How often do you wash dishes?
☐ Once a day ☐ 2–3 times a day ☐ More than 3 times a day

II. Product Use

Is this your first time using EcoScent Dishwashing Paste? ☐ Yes ☐ No

How long did you use the product before answering this survey?
☐ 1 day ☐ 2–3 days ☐ More than 3 days

III. Product Performance Evaluation

Description	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
EcoScent Dishwashing Paste effectively removes grease from dishes.					
The paste produces enough foam during dishwashing.					
The product is easy to rinse off from dishes.					
EcoScent Dishwashing Paste helps reduce unpleasant food odors.					

IV. Sensory Attributes

Description	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The vanilla mint scent of the product is pleasant.					
The texture of the dishwashing paste is easy to scoop and apply.					
The appearance (color and consistency) of the product is acceptable.					

V. Skin-Friendliness and Perceived Antibacterial Effectiveness

Description	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The product feels gentle on my hands during use.					
I did not experience itching, redness, or irritation while using the product.					
I feel that the product cleans dishes hygienically.					

V. Overall User Acceptability

Description	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I am satisfied with the overall performance of EcoScent Dishwashing Paste.					
EcoScent Dishwashing Paste performs comparably to my usual dishwashing product.					
I would consider using EcoScent Dishwashing Paste regularly.					
I would recommend EcoScent Dishwashing Paste to others.					

VI. Open-Ended Questions

What do you like most about EcoScent Dishwashing Paste?

What do you dislike or think needs improvement (e.g., texture, scent, cleaning power, packaging)?

In your own words, how does EcoScent Dishwashing Paste compare to your usual dishwashing product?

Any other comments or suggestions for the researchers?

Appendix B

Product Formulation and Preparation

Figure B1. Ingredients used in the preparation of ecoscent dishwashing paste.

Step 1. Prepare a clean and dry pail or container for mixing the ingredients.

Step 2. Add the premixed degreasing agent (500 g) into the container and mix continuously for approximately 1 minute.

Step 3. Gradually add soda ash (sodium carbonate) (500 g) and mix for 3 minutes until well incorporated.

Step 4. Add the coconut husk ash and continue mixing for another 3 minutes to ensure even distribution.

Step 5. Add the desired amount of colorant and mix until the color is uniformly distributed throughout the mixture.

Step 6. Add the cleaning agent (1 kg) and mix thoroughly for approximately 5 minutes to achieve a consistent paste.

Step 7. Add the hardener (20 mL) and mix for 2 minutes to improve paste firmness.

Step 8. Add the desired amount of vanilla mint scent and mix for an additional 2 minutes.

Step 9. Transfer the finished dishwashing paste into the desired packaging and allow it to rest in a partially covered condition for 24 hours before use.

Figure B2. Preparation process of ecoscent dishwashing paste.

Figure B3. Manual mixing of ingredients during the formulation of EcoScent Dishwashing Paste.

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