

From Kitchen to Cosmetics: The Science of Formulating Natural Toner Using Coconut Juice

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Abstract— This study provided empirical evidence on the safety, quality, and stability of coconut juice as a natural ingredient for skincare formulation and a basis for developing a practical learning material in Home Economics. This research uses a mixed-methods development research design, quantitative descriptive laboratory analysis, and qualitative descriptive analysis. Laboratory testing was performed to determine the physicochemical properties of coconut juice, including pH, mineral and heavy metal content, and the formulation stability of the coconut juice-based toner, including pH and microbiological parameters.

The laboratory-based experiences of thirty student-respondents and three teacher-respondents from Socorro National High School were analyzed using thematic analysis. Results indicated the presence of sodium, potassium, calcium, and magnesium in coconut juice, and the absence of lead, cadmium, and mercury. However, raw coconut juice had an acidic pH of 3.59 and required adjustment before use in skincare. The formulated toner showed good stability, with a pH of 5.74, which is compatible with the skin, and low microbial results for total plate count, coliform, *E. coli*, fecal coliform, and yeast and mold counts. The correlation between physicochemical properties and formulation stability was explored only in a descriptive, expert-based manner, and no statistical significance was determined. Qualitative findings revealed that students became aware of pH, skin safety, and product testing, while teachers perceived the relevance of the activity to Home Economics and TLE teaching. Thus, coconut juice can be utilized in the formulation of skincare products and in classroom-based learning, with the backing of proper laboratory testing procedures.

Keywords— Coconut juice, natural skincare toner, formulation stability, physicochemical properties, Home Economics, TLE, product development, antioxidant skincare, sustainable cosmetics.

I. INTRODUCTION

With the increasing demand for natural and sustainable personal care products, there is scope to explore the locally available resources as alternative cosmetic ingredients [1]. The objective of this study is to scientifically formulate and validate a natural skin care product from coconut juice, a common waste by-product in coconut processing. This underutilized resource can be used to demonstrate the application of scientific principles in Home Economics (HE) education [2]. In particular, it studied the biochemical properties and antioxidant activity of coconut juice, its stability as a toner, and its potential as a safe, inexpensive beauty care product [3], [4]. The research combines sustainability, applied science, and experiential learning to show how common household kitchen ingredients can be turned into useful skin care products.

The bioactive compounds of coconut juice have been studied for their potential effect on skin hydration and antioxidant activity [5, 6]. Coconut juice was identified as a good source of natural antioxidants for topical application. The importance of natural antioxidants from tropical plants for healthy skin was emphasized. Coconut water-based formulations were also suggested to have antimicrobial and moisturizing properties. However, these studies were primarily focused on cosmetic acceptance or commercial testing rather than controlled laboratory work in local or educational settings [7, 8]. This underscores the need for research to be translated into HE instruction and community-level innovation that is both scientifically validated and relevant [9].

However, there are still practical and local gaps, even with available coconut resources and related studies. Coconut juice is often wasted in coconut-producing areas of Mindanao, particularly in Surigao del Norte and nearby areas, especially in small-scale or household processing [10]. Meanwhile, commercial skin care products used by many households and learners are costly and contain synthetic substances. A survey of HE students and community members shows a lack of awareness of how to safely transform food-based materials into products such as skincare.

The Philippine Statistics Authority (2021) highlighted the importance of coconut in agricultural production, yet value addition remains minimal. Commercial and imported products are also having a heavy impact on the local skincare market, making it difficult for low-income consumers to access [11]. Such issues show a disconnect between local resources, scientific knowledge and practice.

This study contributes to the scientific formulation and analysis of a natural cosmetic toner using coconut juice in the context of HE education and local sustainability to fill these gaps. It contains formulation procedures and laboratory testing such as antioxidant activity analysis, and future consumer acceptability testing is recommended [12,13]. The research also demonstrates the use of food-based materials in the production of desirable cosmetic products [14], [15]. This study provides an educational model for HE educators and students. It also promotes waste reduction, value addition of agricultural resources, local innovation, skills development and community awareness [16], [17], [18].

II. MATERIALS AND METHODS

Research Design

This study employed a developmental mixed-methods research design to formulate, test, and validate a coconut juice-based skincare toner, as well as to develop a practical learning material for Home Economics [19]. The quantitative part focused on laboratory parameters such as pH, mineral content, microbial counts, and formulation stability, while the qualitative part described students' and teachers' experiences regarding skincare safety and pH awareness. Such a design was appropriate because it combined measurable laboratory data and experience-based insights to develop HE learning material on natural skincare formulation and the responsible use of local resources.

Research Locale

Socorro National High School, Socorro, Surigao del Norte was selected as the locale of the study. The HE/TLE setting, the availability of student and teacher respondents, and the local availability of coconut juice in the area helped the study focus on practical learning, skincare formulation, product safety, and community-based resource utilization.

Research Respondents

The respondents of the study were the thirty (30) selected Senior High School learners enrolled in HE/TLE subjects and the three (3) HE/TLE teachers of Socorro National High School. The respondents were chosen through the purposive sampling method because of their relevance to the study. The teachers provided instructional insights into the usefulness and applicability of the activity in Home Economics, while the learners engaged in laboratory observations of skincare products with different pH levels.

Research Instrument

Data collection on the physicochemical properties, formulation stability, and laboratory-based experiences related to the coconut juice-based toner was done using laboratory test results, formulation materials, a structured observation checklist and a researcher-made open-ended observation questionnaire. The instruments and materials were validated by experts for clarity, relevance, and alignment with the study objectives, and qualitative trustworthiness was supported through proper coding, thematic organization, and supporting verbatim statements.

III. RESULTS AND DISCUSSIONS

Measurable Physicochemical Properties of Coconut Juice Relevant to its Potential Effectiveness as a Skincare Ingredient

Table 2 presents the physicochemical properties of coconut juice, including its pH level, mineral content, and heavy metal composition based on laboratory analysis. These parameters are examined to determine the safety and potential suitability of coconut juice as a skincare ingredient.

The laboratory findings on the physicochemical properties of coconut juice, including pH, mineral content, and heavy metal content. The results showed that the coconut juice was acidic, which suggests it may need pH adjustment before use in a skincare toner to improve skin compatibility and reduce the risk of irritation. The presence of minerals such as

potassium and sodium also suggests that coconut juice is not merely water but a chemically active natural resource with potential value for formulation. Above all, the absence of lead, cadmium, and mercury makes it a safe raw material for the development of cosmetics [20], [21].

Table 2. Physicochemical Properties of Coconut Juice

Indicator	Parameter	Laboratory Result	Standard/Reference	Interpretation
pH Level	pH @ 25°C	3.59	Skin-friendly range: ~4.0–6.0	Acidic; slightly below ideal range Present in moderate amount; contributes to electrolyte balance
	Sodium (Na)	28.3 ppm	No fixed cosmetic limit	Supports hydration and proper muscle function
Mineral Content	Potassium (K)	0.18% (18)	No fixed cosmetic limit	Relatively high; beneficial for structural and skin-related functions
	Calcium (Ca)	192 ppm	No fixed cosmetic limit	Supports metabolic processes and cellular function
	Magnesium (Mg)	76.7 ppm	No fixed cosmetic limit	Safe; passed standard
Heavy Metal Content	Lead (Pb)	Not Detected	≤ 20 ppm	Safe; passed standard
	Cadmium (Cd)	Not Detected	≤ 5 ppm	Safe; passed standard
	Mercury (Hg)	Not Detected	≤ 1 ppm	Safe; passed standard

The presence of electrolytes, phenolic compounds, vitamins, and other bioactive components in coconut water, which could contribute to its potential use in product development [22], [23]. However, the acidic pH result also indicates that natural ingredients should not be used directly without testing and proper formulation adjustments. As cosmetic ingredients can be influenced by contamination, handling and storage conditions, laboratory tests are still required to confirm the safety, quality and suitability of products for skincare formulation [24], [25].

Level of Formulation Stability of Coconut Juice-Based Toner over a Defined Storage Period Under Laboratory Conditions

Table 3 presents the formulation stability of the coconut juice-based toner in terms of pH level and microbiological parameters, including bacterial and fungal counts. These results are used to determine the safety, quality, and stability of the formulated product.

Table 3. Formulation Stability of Coconut Juice-Based Toner

Indicator	Parameter	Laboratory Result	Standard/Reference	Interpretation
pH Level	pH @ 25°C	5.74	Ideal skin pH: 4.0–6.0	Slightly acidic; within skin-compatible and stable range
Total Plate Count	Aerobic Plate Count (CFU/mL)	<150	≤1000 CFU/mL	Minimal microbial growth; product is microbiologically stable
	Coliform (MPN/mL)	<3.3	Ideally absent	Low; no significant contamination
Indicator Organisms	E. coli (MPN/mL)	<3.3	Ideally absent	Not detected; favorable
	Fecal Coliform (MPN/mL)	<3.3	Ideally absent	Not detected; favorable
Fungal Stability	Yeast and Mold Count (CFU/mL)	<10	Very low preferred	Very low count; excellent resistance to fungal growth

Stability of the coconut juice-based toner with respect to pH level, total plate count, indicator organisms, fecal coliform, yeast, and mould count. The pH value of 5.74 is still in the skin-compatible range. This indicates that during formulation,

the raw coconut juice was modified to make it more suitable as a skincare toner. The low levels of coliform, E. coli, fecal coliform, yeast, and mould also indicate that the product was prepared, handled, and stored under acceptable sanitary conditions. The total plate count was the highest among the microbial parameters but remained within the acceptable limit, indicating the microbiological stability of the toner during the observation period [26], [27].

Topical products should have an appropriate pH, as the skin is naturally acidic, and the skin barrier can be affected, and discomfort can result from improper pH [28, 29]. Studies also emphasize that cosmetic products, especially water-based and natural formulations, should be assessed for microbial safety, as they are prone to contamination due to poor handling, storage, or inadequate preservation [30]. Thus, satisfactory pH and low microbial counts indicate that the coconut juice-based toner has potential safety, stability, and suitability as a natural skincare preparation under laboratory conditions.

Significant Relationship Between the Physicochemical Properties of Coconut Juice and the Formulation Stability of the Coconut-Based Toner

Descriptive comparison was used to compare the physicochemical properties of coconut juice and toner formulation stability, not inferential statistical testing. Thus, the results only show observed trends and not a statistically significant correlation. The most noticeable trend was the change in pH, where the raw coconut juice was acidic, while the formulated toner reached a skin-compatible pH, thus it was necessary to properly formulate and adjust the pH before using coconut juice as a skincare ingredient [20], [28]. The lack of lead, cadmium and mercury also contributed to the safety profile of coconut juice as a raw material. Its measurable minerals showed potential formulation value, which still needs to be supported by stability and safety testing [22], [23], [24].

Low microbial counts in the toner indicated proper handling, hygienic preparation and controlled storage contributed to the safety and quality of the product [25], [30]. Coconut juice is a natural water-based material, which is prone to microbial growth if not properly processed, and laboratory testing is important before using it in cosmetics. The students’ and teachers’ observed experiences on pH awareness, skincare safety, and product formulation as reflected in their responses also supported the educational value of the activity in guiding the development of a practical Home Economics learning material [9], [14].

Observed Laboratory-Based Experiences of Students and Teachers

The observed laboratory-based experiences of students and teachers were collected to determine how they perceived examining skincare products with varying pH levels in relation to skin safety and compatibility. The responses were organized into categories, themes, and sub-themes to present the learners’ laboratory observations and the teachers’ instructional insights. These results supported the development

of practical learning materials in Home Economics focused on natural skincare product formulation.

Table 5.1 Observed Laboratory-Based Experiences of Students

Category	Theme	Sub-theme
Understanding of pH and Skin Safety	Awareness of pH as an indicator of skincare compatibility	Students recognized that skincare products should have an appropriate pH level to avoid possible skin irritation, dryness, or discomfort.
Understanding of pH and Skin Safety	Recognition of the importance of skin-compatible products	Students understood that products with very high or very low pH may not be suitable for the skin and should be evaluated before use.
Observation of Product Stability	Awareness of changes in pH level during storage	Students observed that pH stability is important because changes in pH may indicate possible product instability.
Observation of Product Stability	Recognition of color and odor as visible signs of stability	Students noted that changes in color or odor may suggest spoilage, contamination, or deterioration of the product.
Laboratory Skill Development	Improvement in observation and documentation skills	Students developed basic laboratory skills by recording observations using a checklist and comparing product characteristics.
Laboratory Skill Development	Application of scientific thinking in product evaluation	Students learned that skincare products should be assessed through evidence and not only through appearance, smell, or claims of being natural.
Appreciation of Natural Ingredients	Interest in coconut juice as a local skincare ingredient	Students observed that coconut juice may be used as a natural ingredient when properly formulated and tested.
Appreciation of Natural Ingredients	Realization that natural products still require testing	Students understood that natural ingredients are not automatically safe and must undergo laboratory analysis before being used in skincare.

Table 5.1 shows the qualitative results of the observed laboratory-based experiences of thirty (30) student-respondents in examining skincare products with varying pH levels in relation to skin safety and compatibility. The answers were grouped into four main categories: knowledge of pH and skin safety, recognition of product stability, learning laboratory skills, and respect for natural ingredients. The students demonstrated that they knew pH is important for determining whether a skincare product is suitable for the skin because products that are too acidic or too alkaline may cause irritation, dryness, or discomfort. They also realized that natural ingredients, such as coconut juice, are not inherently safe and still need to be properly tested before they can be used in skincare [20], [28].

Findings also revealed that students could observe product stability through changes in pH, color, odor, and physical appearance, and that the use of checklists helped them improve their observation and documentation skills. Their responses showed that the activity helped them to think based on evidence, as they found that skincare products should not be evaluated by smell, appearance, or natural claims alone, but should be backed up by laboratory testing. The activity enabled students to connect scientific knowledge to real-life skincare problems and to recognize the potential of coconut juice as a local ingredient for natural product development [2], [9], [14].

Table 5.2. Qualitative Results on Observed Laboratory-Based Experiences of Three (3) HE/TLE Teacher-Respondents. The responses were coded from T1 to T3 to ensure confidentiality. The findings were categorized into four categories, i.e., instructional relevance, learner engagement, safety and compatibility awareness, and livelihood and product development. The teachers found the activity useful

for teaching topics related to skincare formulation, pH awareness, product safety, and the practical application of scientific concepts in Home Economics. The activity also engaged students more, as it used familiar materials such as coconut juice, and they were able to relate classroom lessons to real-life product development [2], [14].

Table 5.2 Observed Laboratory-Based Experiences of Teachers

Category	Theme	Sub-theme
Instructional Relevance	Usefulness of the activity in Home Economics instruction	Teachers observed that the laboratory activity can be used to teach students about skincare formulation, product safety, and pH awareness.
Instructional Relevance	Connection between science concepts and practical learning	Teachers recognized that the activity connects chemistry, hygiene, health, and product development in a practical classroom setting.
Learner Engagement	Promotion of active student participation	Teachers observed that students became more engaged because the activity involved hands-on observation and real-life skincare materials.
Learner Engagement	Development of curiosity and inquiry skills	Teachers noted that students showed interest in asking questions about pH, product safety, and the use of natural ingredients.
Safety and Compatibility Awareness	Emphasis on evaluating products before use	Teachers recognized the importance of teaching students that skincare products must be checked for pH, stability, and safety before application.
Safety and Compatibility Awareness	Awareness of possible risks in untested natural products	Teachers observed that the activity helped learners understand that natural ingredients may still cause problems if not properly formulated.
Livelihood and Product Development	Potential for local product innovation	Teachers saw the activity as useful in showing how local resources, such as coconut juice, may be developed into value-added skincare products.
Livelihood and Product Development	Relevance to HE/TLE competencies	Teachers observed that the activity supports practical skills, entrepreneurship, product formulation, and responsible use of local materials in Home Economics.

The teacher-respondents further stressed that the activity gave the learners the opportunity to realize that skincare products, even those made from natural ingredients, should be tested for pH, stability, and safety before use. Their responses showed that the activity promoted responsible product assessment, inquiry-based learning, and awareness of the livelihood potential of the local resources. The results of this study suggest that the analysis of skincare products at different pH levels can be adopted as a practical HE/TLE teaching material in the areas of skincare formulation, product safety, local resource utilization, and entrepreneurship [20], [28], [22].

Proposed Coconut Juice-Based Skincare Toner as a Learning Material

The study concluded that a coconut juice-based skincare toner was successfully developed and proposed as a practical learning material for Home Economics instruction. Laboratory tests and observations indicated that the toner was within an acceptable pH range, had a low microbial count, and exhibited good physical stability, suggesting its potential safety and suitability for skin care formulation. As instructional material, it combines science concepts, practical skills, sustainability, and the use of local resources by providing students with the opportunity to learn pH testing, product safety, formulation

procedures, and value-adding practices using coconut juice. The activity also promotes experiential learning, as students can observe, measure, record, and evaluate the product while developing awareness of natural ingredients, responsible skincare formulation, and potential livelihood or entrepreneurial opportunities.

IV. CONCLUSION

The results suggest that coconut juice has measurable physicochemical properties that support its potential as a raw material for skincare formulation. It contains minerals such as sodium, potassium, calcium, and magnesium, and no lead, cadmium, or mercury was detected, indicating the sample was free from heavy metal contamination. However, the pH of coconut juice was slightly below the ideal skin-compatible range, so it should not be used directly in skincare products without proper pH adjustment. The formulated coconut juice-based toner exhibited good stability in the laboratory, with a skin-compatible pH and a low microbial count, supporting its safety and quality when prepared and stored properly.

Descriptive expert-based analysis was the only method used to interpret the relationship between physicochemical properties of coconut juice and the stability of the toner, and no inferential statistics were used. Although no statistically significant correlation was observed, a trend was observed between the quality of raw coconut juice and the desirable stability of the final toner. The experiences of the student-respondents augmented their awareness of pH, skin safety, product stability, observation, and proper testing of natural ingredients. Similarly, the teacher-respondents said that the activity was relevant to HE/TLE instruction because it addressed science concepts, real-life learning, product safety, the use of local resources, and potential livelihood development.

Recommendation

Coconut juice, though, has potential as a skincare ingredient, according to the researcher, but its pH needs to be adjusted before use because it was slightly below the ideal range for skin compatibility. The sample, although it contains useful minerals and no heavy metals, should be tested in the laboratory, prepared hygienically, properly formulated, and tested for stability before being used topically. The findings can also guide individuals, communities, and aspiring entrepreneurs on the use of coconut juice as a local raw material for value-added skincare products with expert guidance and laboratory validation.

The study output is recommended as a practical learning material in the teaching of Home Economics and TLE. It can help teachers include lessons on the formulation of natural skincare, pH awareness, product safety, hygiene, entrepreneurship, and the responsible use of local resources. Future researchers may improve the formulation by studying longer storage periods, different concentrations of coconut juice, preservative systems, sensory acceptability, skin patch testing, and statistical analysis.

ACKNOWLEDGEMENT

The researcher thanks God for His guidance. Deepest gratitude is extended to Thesis Adviser Lorna L. Estal and Panel Members Jennifer M. Montero (Chairman), Maria Lady Sol A. Suazo, Lowelyn Q. Estoquia, and Daisy E. Salas for their invaluable support. Thanks also to the respondents, Principal I Jocelyn M. Vosotros, family, co-teachers, faculty, and friends for their encouragement.

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