Faculty of Natural and Applied Sciences Journal of Applied Chemical Science Research
Print ISSN: 3027-0359
www.fnasjournals.com
Volume 2; Issue 2; March 2025; Page No. 82-86.

Physicochemical Evaluation of Rice Water-Based Skincare Products Infused with Essential Oils for Domestic Application

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Abstract
The study determined the physicochemical evaluation of rice water-based skincare products infused with essential oils for domestic application. The chemical and physical properties of the skin care products, namely skin cream, face cleanser, and semi-solid soap, and the acceptability level of the products were determined. The study was guided by three research questions and one null hypothesis. The research design used was quasi-experimental. The sample of the study was 390 household members, which was arrived at by the use of Taro Yamane's Formula. Research questions one and two were assessed by professionals through laboratory tests of the products. Data collected were analysed using mean score and standard deviation for research question three, and ANOVA was used to test the null hypothesis. The results revealed that there were parameters of pH, free fatty acid, free alkali content, saponification value, acid value and foam stability for chemical properties; and colour, texture, odour, foam index, hardness, spreadability and physical state for physical properties. The products of skin cream, face cleanser and semi-solid soap had moderate acceptability by their mean rating. The paper recommended that the production of homemade skin care products should take cognisance of skin type, and stability parameters should be employed to increase the acceptability rate of the products for sustainability, among others.

Keywords: Assessment, Production, Skin Care Products, Essential Oils, Rice Water

Introduction

Skincare products are integral to maintaining skin health, and among them, creams, soaps, and moisturisers play unique roles. According to Liang (2020), harsh chemicals and artificial fragrances are common problems that can lead to discomfort and sensitivity, making it important for consumers to be mindful of the ingredients present in their skin care choices. Fragrances play a vital role in enhancing the appeal of cosmetics, influencing both product comfort and effectiveness, and significantly impacting overall cosmetic evaluation. The whole process includes the extraction and processing of essential oils and the preparation of formulations of the skin cream, face cleanser, and the semi-solid soap. Coconut oil is a great moisturiser for all skin types, including dry, oily, and acne-prone skin. It helps to lock in moisture and keep skin hydrated (Usman et al., 2022). Pamplona-Roger (2013) opined that coconut oil is prepared industrially by processing copra under high pressure. According to Dini and Laneri (2022), skin care formulations are enriched with botanical extracts, essential oils and naturally derived ingredients, with the intention of commitment to gentleness, and making the skin care products particularly suitable for individuals with sensitive skin. Chemical property is any of a material's properties that become evident during or after a chemical reaction. The quality that can be established only by changing a substance's chemical identity. The products of skin cream, face cleanser and semi-solid soap undergo physicochemical analysis to assess their properties comprehensively, including physical characteristics, and other relevant chemical attributes. The physicochemical results obtained from the analysis provided insights into the properties of the formulated skin care products, establishing their suitability for household use. It is noted all over the world that plant food items have two types of compounds, namely antioxidants (certain vitamins and minerals), and phytochemicals with curative properties.

All fruits possess anticarcinogenic properties, but citrus fruits are remarkable for their balanced combination of anticarcinogenic substances such as vitamin C, flavonoids, limonoids, pectin and organic acids (Pamplona-Roger,

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2013; Njoku & Eze, 2017). Similarly, Vilela et al. (2019) and Suketsil et al. (2021) noted the percentage composition of citrus limonum's essential oils as limonene (54.6%-94.00%), followed by terpenes (19.1%), sabinene 0.74%, ß-myrcene 1.18% and ß-pinene (0.54%-14.5%) among other components. Further, they reported that triglycerides and lipids each make up 10 percent of rice water composition while starch is present at 9 percent carbohydrates, inositol, phytic acid and inorganic substances are other components of rice water.

Often, skin issues are related to the pH balance of the individual as well as pH of the components in the skincare product formulation (Blaak & Staib, 2018). According to Marto et al. (2018), the pH of the rice water on day 1 was 5.50± 0.08. During the fermentation of rice water, pH decreased from 5.50± 0.08 to 4.25± 0.20. When milk was added to the fermented rice water, pH increased to 7.03± 0.05. Rice water is rich in vitamins, especially B and C, and consists of potassium, iodine, magnesium, zinc, selenium and manganese. Basically, Suketsil et al. (2021) stated that a chemical property describes the ability of a substance to undergo a specific chemical change. According to Vilela et al. (2019) a chemical property is any of a material's properties that becomes evident during, or after a chemical reaction. Physical properties are characteristics of a substance that can be observed or measured without changing the identity of the substance. Physical properties include color, density, hardness, and melting at boiling points. For instance, physical properties of rice include grain dimensions, hardness, grain friction, density and thermal aspects. Physical properties differ with variety, moisture content and degree of milling (Suketsil et al., 2021). Acceptability is about human judgement based on perceptual measurement, which depends on the variable on the evaluation instrument and the product presented. Ezekiel et al. (2017) noted that the acceptance of the products depends on meeting the needs and satisfaction of consumers on utilization of the product. The outcome of this study based on the assessment of the parameters of chemical properties, physical properties, and acceptability of the products by the professionals and household members would foster economic innovation in cosmetics production.

Statement of Problem

The human skin is the most exposed organ to the external environment and represents the first line of defence against external chemical and microbial threats; therefore, measures should be taken to protect it, especially the use of organic ingredients suitable for the skin. There are types of skin conditions necessitating the type of cosmetics. Either a skin is sensitive or acne prone, and in addition the skin could be a combination of oily and dry skin or normal skin. Most often, sensitive skin is always dry, although it can be oily, normal or combination skin type. Acne prone skin is influence by factors such as oily skin, hormones, diet, some skin care products, and skin care routine. However, using the correct skin care products depending on the agents incorporated in the formulation can be helpful as anti-acne, soothing, moisturizing, smoothing, and protective, hence the need for this study. Physicochemical evaluation of rice water-based skincare products infused with essential oils for domestic application.

Aim and Objectives of the Study

The main aim of the study was to determine physicochemical evaluation of rice water-based skincare products infused with essential oils for domestic application. Specifically, the study determined:

1. chemical properties of the skin cream, face cleanser and semi-solid soap produced from rice water and oils from coconut, lemon and oranges.
2. physical properties of the skin cream, face cleanser and semi solid soap produced from rice water and oils from coconut, lemons and oranges.
3. acceptability level of the produced skin cream, face cleanser and semi-solid soap produced from rice water, oils from coconut, lemon, grape and orange.

Research Questions

The research questions answered are:

1. What are the chemical properties of the skin cream, face cleanser and semi-solid soap produced from rice water and essential oils from coconuts, lemons and oranges?
2. What are the physical properties of the skin cream, face cleanser, and semi-solid soap produced from rice water and essential oils from coconuts, lemons and oranges
3. What is the acceptability level of the produced skin cream, face cleanser and semi-solid soap?

Hypothesis:

Ho: There is no significant difference across household members on the acceptability level of the products of skin cream, face cleanser and soap produced from rice water and essential oils from coconut, oranges, and lemon.

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Methodology

The research design adopted for the study is a quasi-experimental design. Four research questions and one hypothesis were formulated to guide the study. The area of the study is Omoku Town, in the Ogba/Egbema/Ndoni Local Government Area of Rivers State. The population of the study is 200, 000 and a sample size of 390 households was selected using a multistage Sampling Technique. The instrument for data collection was structured questionnaire, which was designed by the researchers and validated by three experts in Home Economics who are professors in the course of study. The instrument has the acceptability parameters of VA = Very acceptable, MA = Moderately Acceptable, A = Acceptable, U = Undecided. The reliability of the instrument was determined using test-retest and a coefficient of reliability obtained using Pearson's Product Moment Correlation Coefficient, obtaining a value of 0.83 and 0.88 for the two instruments, making them reliable. The data were collected from respondents with the help of two research assistants, using the questionnaire. The data obtained was analysed using descriptive statistics to obtain the results for the research questions, while Analysis of Variance (ANOVA) was used to obtain the results for the hypothesis at a 0.05 level of significance.

Results

Assessment of the chemical and physical properties of some homemade skin care products made from rice water and essential oils for household utilisation had results in chemical and physical properties of skin cream, face cleanser, and semi solid soap, and acceptability level of the produced skin cream, face cleanser, and semi solid soap.

Research question 1: What are the chemical properties of skin cream, face cleanser and semi solid soap produced from rice water and essential oils form coconuts, lemons and orange?

Table 1: Chemical Analysis of Skin Cream, Face Cleanser and Semi Solid Soap

Parameters	**Samples**			
	Skincare%	Cleanser%	Soap%	
P^H	8	5		9.5-10.0
Free fatty acid	-	-		-88
Free alkali content	-	-		0.01
Saponification value	37.9	-		-
Acid value	6.73	-		-
Foam stability	50	-		80

Source: Field Survey, 2024.

Table 1 shows that pH ranges from 9.5-10, and the Analyst stated that it is in agreement with most commercial soaps in our homes and market places. Free fatty acid shows none for skin cream and cleanser, but had -88% for soap. The maximum free fatty acid is recommended to be 2.5% because free fatty acid are important contributor to the quality of soap. The data also showed that free alkali content had none for skin cream and face cleanser but had 0.01%, which clearly meets the standard requirement that free alkali content should not exceed 0.10%. For saponification value, soap and cleanser had none, but cream had 37.9%. Also, the acid value is only on the skin cream with a percent of 6.73. In addition, foam stability had 50% for cream, and 80% for soap and none for face cleanser. Foam is one of the parameters that determines the quality of bath soaps as it increases the detergency capacity of the soap.

Research question 2: What are the physical properties of the skin cream, face cleanser and semi solid soap produced from rice water and essential oils from coconuts, lemons and oranges?

Table 2: Physical Properties of Skin Cream, Face Cleanser and Semi Solid Soap

Parameters	**Samples**			
	Cream	**Cleanser**	**Soap**	
Colour	White	Silver		Light brown
Texture	Smooth	Smooth		Smooth
Odor	Strong/pleasant	Light/pleasant		Strong/pleasant
Foam index	50%	-		91.5%
Hardness	Soft	Soft		Slightly hard
Spread Ability	50gcm/min	-		-
Physical State	Semi-liquid	Semi-liquid		Solid

Source: Field Survey, 2024

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Data in Table 2 shows the physical properties of the products (cream, cleanser and soap) and the parameters are colour, texture, odour, foam index, hardness, spreadability and physical state. The table above shows that all the samples have their unique colour, fragrance and physical state. The products are of colours white, silver, and light brown for cream, cleanser and soap, respectively.

Research question 3: What is the acceptability level of the produced skin cream, face cleanser and semi solid soap?

Table 3: Mean and Standard Deviation of the Respondents on Acceptable Level of the Produced Skin Cream, Face Cleanser and Semi Solid Soap

Products	VA	MA	A	NA	U	Mean	SD	Remark
Skin cream	155 (775)	81 (324)	49 (147)	50 (100)	55 (55)	3.59	4.55	A
Face cleanser	149 (745)	86 (344)	59 (177)	46 (92)	49 (49)	3.61	4.34	A
Semi- solid soap	160 (800)	72 (288)	80 (240)	40 (80)	37 (37)	3.71	5.03	A
Cluster Mean						3.63	4.64	A

Key: VA=very acceptable; MA= moderately acceptable; A= acceptable; NA= not acceptable; U= undecided; Remark of A = acceptable; Criterion mean = 3.00

- Frequency before the parenthesis
- Rated value in parenthesis
-

Table 3 shows the mean responses of the respondents who volunteered to utilize the products produced to answer the research question on an acceptable level of the products, namely skin cream, face cleanser and semi-solid soap. The mean responses on skin cream 3.59, face cleanser 3.61 and semi-solid soap 3.17 are above the criterion mean of 3.00. The standard deviation from the frequency ranged from 4.34 to 5.03, which implies close dispersion.

Hypothesis: There is no significant difference across household members on acceptability level of the products of skin cream, face cleanser, and semi solid soap produced from rice water and essential oils from coconuts, oranges and lemons.

Table 4: Summary of ANOVA Result on the Acceptability Level of the Produced Skin Cream, Face Cleanser and Semi Solid Soap

Sources of Variation	df	Sum of Square	Mean of Square	F-cal	F-crit	Remark
Between groups	2	0.29	0.15	0.10	3.47	NS
Within groups	21	30.93	1.47			
Total	23	31.22	1.62			

NS= Not significant at p>0.05

Table 4 shows the Analysis of Variance (ANOVA) on the different products of skin cream, face cleanser and soap. The calculated F- ratio of 0.10 is less than the critical value of 3.47 at 2 and 21 degrees of freedom under 0.05 level of significance. Therefore, the null hypothesis of no significant difference on the acceptability of the products of cream, cleanser and soap by the panellists of the sensory evaluation is accepted. There is no significant difference in the judgement of the products.

Discussion

Research question one shown in Table 1 sought to determine the chemical properties of the skin cream, face cleanser and semi solid soap produced from rice water and essential oils derived from coconuts, lemons and oranges. The parameters of chemical properties are pH, free fatty acid, free alkali content, saponification value, acid value, and foam stability are given percent values in table 1. According to Vilela et al (2019) a chemical property is any of a material's properties that becomes evident during, or after a chemical reaction. Also, Blaak and Staib (2018) noted that skin tissues and components of skin care products are related to pH balance of individuals.

From Table 2, in terms of texture, the products are all smooth. The cream and soap have strong pleasant smell (fragrance) while the cleanser had a mild pleasant smell. Also, for hardness both the cream and cleanser are soft while the soap is slightly hard. Further, it is noted that all the samples have their unique fragrance, and colour.

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The cream has a white colour and the cleanser has a silver colour. The cream and soap have a strong, pleasant smell (fragrance) while the cleanser has a mild, pleasant smell. The physical properties of skin cream, face cleanser and semi-solid soap made from rice water and essential oils had findings based on parameters of colour, texture, odour, foam index, hardness, spreadability and physical state. Skin cream had physical properties of white colour, smooth texture, strong and pleasant smell, 50% foam index, 50gcm/min spread ability, and liquid physical state. Face cleanser had physical properties of silver colour, smooth texture, light pleasant fragrance, no foam index, and soft and semi-liquid, while soap had light brown colour, smooth texture, strong and pleasant smell, foam index of 91.5% and solid physical state. This agrees with the statement of Suketsil et al (2021) that physical properties include colour density, hardness, and melting at the boiling point. They also asserted that physical property is the characteristics of a substance that can be observed.

From Table 3, the products have acceptable levels of moderately acceptable levels when approximated to a single digit. According to Ezekiel et al (2017) the acceptance of a product depends on meeting the needs and satisfaction of the consumer on the utilisation of the product. This is because acceptability is about human judgment based on perceptual measurement.

Conclusion

The study assessed chemical and physical properties of home-made skin products, as well as acceptability levels of the homemade skin care products produced from rice water and essential oils for skin treatment and family sustainability among household members in Omoku. The study revealed not significant ($p>0.05$) responses in acceptability level of the produced skin cream, face cleanser and semi solid soap. Chemical and physical properties are essential parameters in the assessment of every product that can meet the quality standard of homemade products by providing necessary information that would aid consumers' choice. Since the products are acceptable by the results, they can improve skin health of household members who are the end users and also become a source of income for the producer.

Recommendations

The following recommendations are made based on the findings

- Further research should be carried out by students in the utilization rice water, essential oils from citrus, avocado pear oil and alloy vera for home-made cosmetics.
- Stabilization parameters in production of cosmetics should be employed. This would help to increase the acceptability rate of the products for sustainability.

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