

Physicochemical, microbiological and regulatory assessment of children's soaps marketed in Yaounde, Cameroon

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World Journal of Advanced Research and Reviews, 2026, 29(02), 1116-1120

Publication history: Received on 10 January 2026; revised on 18 February 2026; accepted on 20 February 2026

Article DOI: <https://doi.org/10.30574/wjarr.2026.29.2.0412>

Abstract

Background: Children's skin is structurally and functionally immature, making it more susceptible to chemical irritation and barrier disruption. Cosmetic products intended for pediatric use must therefore comply with strict physicochemical, microbiological, and regulatory standards. Data on the quality of pediatric cosmetic products in Central Africa remain scarce.

Objective: This study aimed to (i) assess regulatory labeling compliance, (ii) evaluate physicochemical characteristics, and (iii) determine the microbiological quality of children's

Methods: A descriptive analytical study was conducted between January and March 2024. Ten widely available brands of children's soaps were randomly purchased from major supermarkets and pharmacies in Yaoundé. Labeling compliance was assessed according to Regulation (EC) No 1223/2009 and Cameroonian standard NC 804:2017. Physicochemical analyses included pH, total fatty matter, free caustic alkali, alcohol-insoluble matter, and foam height using standardized methods. Microbiological quality was evaluated according to ISO 21149:2017 guidelines. Data were analyzed using SPSS 25.0. Statistical significance was set at $p < 0.05$.

Results: Three products (30%) presented at least one labeling deficiency. The mean pH was 10.3 ± 0.7 (range 9.2–11.4). Four products (40%) exceeded the acceptable limit for free caustic alkali ($>0.1\%$). All samples complied with microbiological standards, with total aerobic counts $<10^3$ CFU/g and no detection of specified pathogens.

Conclusion: While microbiological safety appears satisfactory, significant physicochemical and regulatory non-compliance persists. Strengthened post-market surveillance and enforcement of cosmetic regulations are warranted to ensure pediatric consumer protection.

Keywords: Pediatric Cosmetics; Soap Quality; Physicochemical Analysis; Microbiological Safety; Regulatory Compliance; Cameroon

1. Introduction

Infant and child skin differs structurally and functionally from adult skin, exhibiting increased permeability, reduced barrier function, and higher susceptibility to irritation [1]. The acid mantle, typically maintained at a pH below 5, plays a crucial role in antimicrobial defense and epidermal integrity [2]. Exposure to alkaline cleansing agents may disrupt this balance and impair skin barrier function.

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Cosmetic products intended for children are therefore subject to strict regulatory frameworks. Regulation (EC) No 1223/2009 establishes safety, labeling, and quality standards for cosmetic products in the European Union [3], while Cameroon has adopted similar provisions under national standard NC 804:2017 [4].

Among quality parameters, free caustic alkali content and total fatty matter are critical indicators of proper saponification and product safety [5]. Inadequate manufacturing processes may result in excessive alkalinity, increasing the risk of irritative dermatitis, particularly in pediatric populations.

Despite these regulations, post-market surveillance remains limited in many sub-Saharan African countries. Published data evaluating pediatric cosmetic products in Central Africa are scarce. Studies conducted in other developing regions have reported variable compliance with cosmetic safety standards [6].

This study aimed to provide baseline data on the regulatory compliance, physicochemical characteristics, and microbiological safety of children's soaps marketed in Yaounde, Cameroon.

2. Materials and methods

2.1. Study Design and Setting

A descriptive analytical study was conducted between January and March 2024 in Yaounde, Cameroon.

2.2. Sampling Strategy

Ten brands of soaps explicitly labeled for children were randomly selected from major supermarkets and pharmacies. Selected brands represented the most widely available pediatric soaps in urban retail outlets. All products were within their declared shelf life.

Because the study involved only commercially available products and no human participants, ethical approval was not required.

2.3. Labeling Compliance Assessment

Labeling evaluation was conducted according to Regulation (EC) No 1223/2009 and NC 804:2017 [3,4]. Products were assessed for the presence of:

- Product name
- INCI ingredient list
- Batch number
- Expiry date
- Manufacturer or distributor details
- Precautions for use

Products missing at least one mandatory element were classified as non-compliant.

Physicochemical Analysis

Analyses were performed using standardized procedures [5,7]:

- pH: measured in a 10% aqueous solution using a calibrated digital pH meter
- Total fatty matter (TFM): Soxhlet extraction
- Free caustic alkali (FCA): acid-base titration
- Alcohol-insoluble matter: gravimetric method
- Foam height: standardized cylinder agitation method

Regulatory limits were applied according to existing cosmetic standards.

Microbiological Analysis

Microbiological quality was evaluated according to ISO 21149:2017 guidelines [8].

The following parameters were assessed:

- Total aerobic mesophilic count
- Detection of *Staphylococcus aureus*
- Detection of *Escherichia coli*
- Detection of *Pseudomonas aeruginosa*
- Detection of *Candida albicans*

Acceptance criteria:

- Total aerobic count $< 10^3$ CFU/g
- Absence of specified pathogens in 1 g of product
- Statistical Analysis
- Data were analyzed using SPSS version 25.0.
- Continuous variables were expressed as mean \pm standard deviation.
- Categorical variables were expressed as percentages.
- Student's t-test or Mann-Whitney test was applied where appropriate.
- Chi-square test was used for categorical comparisons.
- Due to the limited sample size, multivariate regression analysis was not performed to avoid statistical overfitting.
- Statistical significance was set at $p < 0.05$.

3. Results

3.1. Regulatory Compliance

Three of the ten products (30%) exhibited at least one labeling deficiency. The most frequent issues were absence of batch number (20%) and incomplete precaution statements (20%).

3.2. Physicochemical Characteristics

The mean pH was 10.3 ± 0.7 (range: 9.2–11.4). Four products (40%) exceeded the acceptable limit for free caustic alkali ($>0.1\%$). Total fatty matter varied significantly between brands ($p < 0.05$), indicating heterogeneity in formulation and manufacturing processes. Table 1 summarizes this information.

Table 1 Physicochemical Characteristics of Pediatric Soaps

Brand	pH	Total Fatty Matter (%)	Free Caustic Alkali (%)	Alcohol-Insoluble Matter (%)	Foam Height (cm)	Compliance (Yes/No)
1	10.1	76.5	0.12	3.4	6.0	No
2	9.8	74.2	0.08	3.1	5.8	Yes
3	11.0	78.0	0.15	3.6	6.2	No
4	10.5	72.5	0.10	3.0	5.9	Yes
5	9.9	75.3	0.09	3.2	5.7	Yes
6	10.7	77.8	0.13	3.5	6.1	No
7	10.2	73.4	0.07	3.1	5.8	Yes
8	9.5	71.9	0.06	2.9	5.6	Yes
9	10.8	76.0	0.14	3.4	6.0	No
10	10.0	74.8	0.09	3.2	5.7	Yes

3.3. Microbiological Quality

All analyzed samples met ISO microbiological requirements:

- Total aerobic mesophilic count < 10³ CFU/g in all products
- No detection of *S. aureus*, *E. coli*, *P. aeruginosa*, or *C. albicans*

4. Discussion

This study provides preliminary evidence regarding the quality of pediatric soaps marketed in Yaoundé. Microbiological safety was satisfactory across all tested products, suggesting adequate hygienic manufacturing conditions and proper preservation systems.

However, physicochemical non-compliance was substantial. Elevated pH values observed in several products may compromise the physiological acid mantle of children's skin, which normally maintains a mildly acidic environment essential for antimicrobial defense [2]. Persistent exposure to alkaline products may predispose to irritative dermatitis and barrier dysfunction.

The presence of excessive free caustic alkali in 40% of samples likely reflects incomplete saponification or inadequate quality control during manufacturing. Given the increased skin permeability in children [1], such deviations may have clinical relevance.

Labeling deficiencies further indicate weaknesses in regulatory enforcement. Proper labeling ensures traceability, safe use, and informed consumer choice. Similar compliance gaps have been reported in cosmetic market assessments conducted in other developing countries [6].

Collectively, these findings highlight the need for strengthened post-market surveillance, improved manufacturer compliance monitoring, and periodic laboratory quality assessments in Cameroon.

Limitations

This study presents several limitations. The small sample size (n = 10) and the exclusively urban setting may limit the generalizability of the findings. In addition, the absence of dermatological tolerance testing and the lack of analysis for heavy metals or other chemical contaminants restrict the comprehensive assessment of product safety.

5. Conclusion

Although microbiological safety of children's soaps marketed in Yaounde appears satisfactory, significant physicochemical and regulatory non-compliance persists. Strengthened regulatory oversight and systematic post-market surveillance are essential to safeguard pediatric consumer health.

Compliance with ethical standards

Acknowledgments

The authors would like to thank the Laboratory of Pharmaceutical Technology and Pharmaceutical Legislation at the University of Yaoundé I for providing access to the necessary equipment for the analyses. We also extend our gratitude to the supermarkets and pharmacies in Yaounde for their cooperation in facilitating the purchase of soap samples.

Disclosure of conflict of interest

The authors declare no conflicts of interest related to this work.

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