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Research Article

Formulation and Evaluation of a Laterite Soil Based Scrubbing Effect Herbal Cleansing Bar

N.U.S. Dissanayake ^{a*}, P.G.H. Pupulewatte ^a, D.T. Jayawardana ^b

^a University of Sri Jayewardenepura, Faculty of Applied Sciences, Department of Forestry and Environmental Science, Gangodawila, Nugegoda, Sri Lanka.

^b Center for Forestry and Environment, University of Sri Jayewardenepura, Faculty of Applied Sciences, Department of Forestry and Environmental Science, Gangodawila, Nugegoda, Sri Lanka.

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*Address for Correspondence:

N.U.S. Dissanayake, University of Sri Jayewardenepura, Faculty of Applied Sciences, Department of Forestry and Environmental Science, Gangodawila, Nugegoda, Sri Lanka

Abstract

Cosmetics play a dynamic role for every person to have a glad and confident life. In the current scenario, herbal cosmeceuticals have more demand because they have no side effects. People often suffer from acne, whiteheads, and blackheads, so scrubbing becomes essential. The main objective of the present study was to prepare a herbal-mineral facial scrubbing effect cleansing bar. Majorly facial skin comes in direct contact with dirt, pollution, dust particles, and many dead cells. Some facial preparations are required to remove the dead cells and make the skin in fine fettle, cleaned, and nourished. The present study formulated a laterite soil-based herbal scrubbing effect cleansing bar for all typed skin using laterite soil powder. In contrast, glycerin soap base, virgin coconut oil, olive oil, bee honey, aloe vera, lime juice, turmeric, and lavender essential oil are used and evaluated by using various parameters such as physical appearance, color, odor, pH, washability, irritants, stability studies, microbial tests, heavy metals, and total fatty matter. It was given fruitful results with all the tests. The herbal formulation had characteristic pleasant order, reddish-brown in color having, light, non-irritant to the skin and quite an elegant, microbial and heavy metal safe product. Thus, the formulated scrubbing effect facial cleansing bar can be utilized efficaciously without a side effect that exfoliates makes healthy, clean, and glowing skin.

Keywords: Facial scrub, Cosmetic, Herbal, Mineral, Laterite soil

1. INTRODUCTION

Skin is the largest and one of the principal organs of the body. It serves as a significant defensive organ for the other body parts. Skin plays the role of a shielding cover, keeping everything beneath it and harmless from day-to-day threats such as the severe effects of the sun, wind, pollution, and germ-filled ¹. Cosmetics are well-defined as the products used to clean, highlight, endorse, charm, or alter the appearance. Different herbs were used to wash, embellish, and manage their beauty from the prehistoric period. Facial skin is the most critical part of the body, which indicates the healthiness of an individual ². As growth mature, the speed of cell turnover slows down intensely. The majorly dead cells set up on facial skin surface hang around much longer, which tends to bring out those fine lines and can make skin consistency dull and lifeless ³. To endure a healthy and of presence look, the skin surface necessitates frequent cleansing to remove sebum and other secretions, dead cells, and applied make-ups ⁴. The main factors to think through are skin type, key ingredients, pH level, antimicrobial effect, product testing data ⁵.

Skins are mainly three types as dry skin, oily skin, and sensitive skin. People who have dry skin essential use a facial scrub that contains hydrating components, and moisturizer is a must for them. Mild scrub should be used for sensitive skin.

It is important for those who have oily skin to get a scrub that exfoliates extremely to avoid the pores from clogging and balance the skin oil production.

Total Fatty Matter (TFM) is one of the utmost imperative features describing the superiority of the soap. A low TFM value is regularly linked with hardness and lower quality of the soap. In the old days in Europe and some nation - states, soap with TFM 75% minimum was brought up as a grade I and 65% least possible as grade II. The soap with the higher TFM offers more lather, keeps on longer and more excellently, cleans one's skin better and softer. The least quality soap (Grade III) has at least 60% TFM ⁶.

Cosmetic products are considered substrates for the continued existence and growth of an extensive range of microorganisms. The being there of pathogenic microorganisms in cosmetic products can pose a health hazard for users. The use of additives, good manufacturing practices, and quality control programs have technologically advanced the quality, but many studies have given account cases of contaminated cosmetic products ⁷⁻⁹. The cosmetic products specifically intended for adults should have no more than 103 CFU/g or mL of aerobic mesophilic microorganism and *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans*, and *Escherichia coli* must not be detectable in 0.1 g or

0.1 mL ¹⁰. Inhibit the microbial contamination of cosmetic products, chemical ingredients with known antimicrobial properties are used. But, preservatives are known as one of the most relevant allergens found in cosmetic products ^{11,12}.

In the manufacturing of stained makeups, mineral pigments are usually used, which leads to the contamination of beautifying products with heavy metals such as Cu, Ni, Co, Pb, Cr, Cd, Hg, and As. ¹³ showed that the availability of Pb in lipstick, eyeliner, and pencil eye like cosmetics used in Nigeria, ranged from 78 to 123 µg/g. Some studies revealed that most cosmetics industrialists and industrial units use heavy metals to lengthen the shelf life of the products ^{14, 15}. In recent years, several pieces of research have made known that there is a direct relation between these cosmetic products and the incidence of types of cancer, skin sensitivities, respiratory disorders, fertility problems, multiple abortions, and genetic disorders ^{15, 16}.

Most of the existing cosmetic products in the local and international market contain synthetic chemical ingredients such as microplastics, propylene glycol, methylparaben, and propylparaben that can cause irritation to the sensitive skin and may contaminate the environment. By rub in natural materials for exfoliating the skin physically with a scrub using herbal products contain vitamins, antioxidants, purifies and

anti-aging material goods which benefits to deep cleanse the skin and make it glimmering and gorgeous ^{17, 18}. The present work aimed at formulating the scrubbing effect cleansing bar containing herbal gelling agent (aloe vera), humectants (honey, turmeric), coloring agent (laterite soil, turmeric) so that it has no adverse effects and contains herbal products also as excipients.

2. MATERIALS AND METHODS

2.1 Materials

Naturally available laterite soil was collected from the Western province of Sri Lanka by auger drilling method. Laterite soil was washed several times using distilled water to remove impurities, air-dried 48 hours to remove excess moisture, ground and sieved using 500 µm sieve and thermally activated at 300 °C for 3 hours in a muffle furnace.

The 500 µm 300 °C activated laterite soil powder, glycerin soap base, virgin coconut oil, olive oil, bee honey, aloe vera gel, lime juice, turmeric powder, and lavender essential oil were used to formulate the product. The components with their major usages are enlisted in Table 1.

Table 1: Formulation of Herbo – mineral scrubbing cleansing bar

Ingredients	Uses	Quantity (g)
Glycerine soap base	Emollients and as the matrix.	75 g
Virgin coconut oil	Nutrient, skin tonic and emollient.	2.5 g
Olive oil	Nutrient, skin tonic and emollient.	2.5 g
Bee honey	Antiseptic, antioxidant, humectants and as nutrient	5 g
Aloevera	Antioxidant, moisturizing agent and brings smoothing property	5 g
Turmeric powder	Antiseptic, improves fairness, antibacterial, antifungal and brings radiance to the skin.	1 g
Lime juice	Lighten the skin tone, remove dark spots and skin tan.	5 g
Laterite soil	Removes dirt, chemicals, poisons, and other micro-particles from the surface of the skin, brings flawless complexion and clears acne, exfoliator, gently removes impurities and dead cells, leaving skin instantly smooth	2 g
Lavender essential oil	Perfuming agent	2 g

2.2 Physicochemical properties of laterite soil

The morphology of the adsorbent surface was studied using scanning electron microscopy (SEM - EDX). Gold sputtered ground soil samples were mounted on an SEM sample container with double-sided conductive carbon tape for analysis. At a steady current of 25 mA, gold sputtering of ground soil was accomplished ¹⁹. The Rigaku NEX CG EDXRF analyzer was used to examine the composition of laterite soil using an X-Ray fluorescence spectrometer (XRF) ^{20, 21}. The mineral components were identified using an X-Ray diffractometer (XRD) analysis utilizing a Rigaku TTRAX III XRD equipment with Cu K (alpha) radiation and a wavelength (1.54 Å) over 2 (theta) of 5-700 with a step size of 0.020 ²². Using a Nicolet iS10 spectrometer and the KBr-pellet technique, a Fourier transform infrared spectrometer (FTIR) was utilized to determine the type of functional groups present in the adsorbent. Spectra were obtained between 4000-400 cm⁻¹ ¹⁹.

2.3 Preparation of scrubbing effect cleansing bar

Glycerin soap base was melted following double boil method and virgin coconut oil, olive oil, bee honey, aloe vera gel, lime juice, turmeric powder, activated laterite soil, and lavender essential oil mixed together to get a mixture with the best consistency (Table 1). The mixture was poured into the silicone mold for solidifying.

3. EVALUATION OF PRODUCT PERFORMANCE

3.1 pH, color, odor, washability, patch test and stability test

Color, odor and pH were examined for the mixture. The color of the product was tested visually, and the odor was evaluated by smelling it. pH was measured by dissolving 1g of the product in 9 mL of deionized water and measured by using the pH meter ^{23, 24}.

A waterproof lipstick was applied to the cheek to check the washability. After a few hours, the product was applied on top of it, and it was kept for 15 minutes. Then it was rinsed off with water while scrubbing gently. The same procedure was continued with the waterproof liquid foundation^{23,24}.

Approximately 400 mg of the scrub was applied on the bend of an elbow or behind the ear of each volunteer as a patch with a diameter of about 1 inch. It was kept for 48 hours and rinsed off with water. Any negative or positive reactions to the product were recorded by questionnaire. Compatibility tests such as Skin irritancy, Erythema reactions (Reddening), Edema (Swelling) and toxicity were tested according to the views of the 100 random volunteers. Acceptability tests were done by using the reviews and opinions of the volunteers on the scrub. Properties such as washability, fragrance, and moisturizing ability were tested^{23,24}.

The stability of the product was tested by covering with plastic wrapping and placing it in a humidity chamber at 45°C, exposing it to sunlight and 75% relative humidity²⁵. The accelerated stability of the formulation was examined for 1 month (Table 2).

3.2 Total Fatty Matter (TFM)

Five grams of soap were weighed up and transmitted into a 200 mL beaker. 100 mL of hot deionized water was added to completely dissolve the soap. 40 mL of 0.5 M Nitric acid was mixed until solutions were to some extent acidic. The mixture was heated in a water bath up until the fatty acids were floating as a layer above the solution. The fatty acids were cooled in an ice bath and separated. 50 mL of chloroform was mixed to the left behind the solution and transferred to a separating funnel. The solution was shaken and allowed to separate into two layers. The bottom-most layer was drained. 50 mL of chloroform was added to the remaining solution in the separating funnel. The fatty acid dissolved in chloroform was separated again as in the earlier case and transferred to the collected fatty matter. The fatty matter was weighed in a pre-weighed container. It was allowed the contents to evaporate and weighing the residue. The percentage of fatty matter in the given soap sample was calculated from the difference in weight⁶.

$$\% \text{ of Fatty Matter} = \frac{\text{Weight of soap after drying}}{\text{Weight of soap sample}} \times 100 \quad \text{Eq. 1}$$

3.3 Total aerobic microbial count and absence tests for pathogenic microorganisms

A sample of 1 g was fully dissolved in 10 mL of saline buffer, the ratio of 1:10 between sample and buffer. The dilution series of this initial suspension was prepared using the same buffer. The volume equivalent to 1 mL of sample was transferred to sterilize nutrient agar petri dish and spreaded the sample properly following spread plate method. The Petri dishes were incubated upside down at 32.5 °C ± 2.5 °C for 24 to 48 h. The number of colonies was counted and the plates consist of 30 to 300 colonies were in use into concern. The outcomes were conveyed as number of microorganisms per gram of sample²⁶.

The absence test of microorganisms was implemented for the pathogenic microorganisms of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans* and *E. coli*. Using the 1:10 dilution, 1 g of soap sample was dissolved in 10 mL of saline water. The decimal dilutions of initial samples (10⁻¹ to 10⁻⁶) were prepared and 1 mL of the solutions was transferred to sterilize agar medium plates. After spreading the solution properly, plates were incubated at 32.5 °C ± 2.5 °C for 24 to 48 h. After that, subcultures were prepared on plates containing Violet Red Bile Glucose Agar (VRBGA), which were incubated

at 32.5 °C ± 2.5 °C for 18 to 24 h. The product act in accordance with the test if there is no growth of the colonies²⁶.

3.4 Heavy metals

The sample was examined for As, Cd, Hg, and Pb. Sample preparation for the determination of heavy metals was done following the method of²⁷. About 1.0 g of the sample was digested in a 5.0 mL mixture of concentrated acid HNO₃:HClO₄ (3:1) for 2-3 hours on a hot plate at 90 °C. Then, 3.0 mL of the acid mixture was mixed again and heated for another 2-3 hours to complete the digestion. The above-digested sample was cooled and about 5.0 mL of deionized water was added to the mixture. The solution was mixed well and volume was made up to 25 mL in a volumetric flask. The solution was filtered through a Whatman filter paper. A clear solution was used for metal quantification. The coupled plasma mass spectrometer (ICP-MS) determined the concentration of heavy metals.

4. DATA AND DISCUSSION

4.1 Physicochemical properties of laterite soil

Laterite soil includes diverse varieties of physical and chemical characteristics. As major physical features, acidic nature, oxidizing conditions, and lower elution conductivity can be recognized. According to the SEM analysis, laterite soil's adsorption surface has a very porous structure with a heterogenous texture. EDX analysis proved that, having shallow contents of organic matter and inorganic carbons. XRF data showed that the oxide state of Ferrous, Aluminium, Silicon, and Titanium exist as the major oxides in laterite soil, while the amounts of liable oxides, including CaO, MgO, Na₂O, and K₂O are very lower in this soil type. Trace elements, including Zn, Ni, Co, Cu, Cd, and Pb, are absent or insignificant in detection.

Based on the XRD data, various types of minerals are present in laterite soil, including primary minerals such as Quartz, secondary minerals like Hematite, Goethite, Kaolinite, and Gibbsite. Previous studies of^{20,28} have similar outcomes for laterite soil. These minerals and clays help raise the impurities removal properties of laterite soil by increasing ion exchange and adsorption capacity²⁹. The internal structure of the laterite soil is facilitated to increase its contaminants removal ability. The FT-IR analysis done in the laterite soil proved several bonds present there, such as O-H, Fe-OH, Si-O-Si, and Al-OH, which may simplify to adsorb contaminants that we accumulate during daily activities. Si-O-Si bonds perform a major role in the adsorption of heavy metals³⁰.

4.2 Physical & chemical parameters, patch test and stability parameters

The formulated, herbal-mineral scrub was assessed at different parameters. Color and odor were tested visually. As a result, color was observed as reddish-brown. No bad smell occurred from the formulation and having a characteristic odor. The pH of the preparation was tested and found 7.9 worth of proper skin. Washability properties bring into being good, as it is without difficulty removed by washing with normal water. It is non-irritant, has no redding or swelling, and has no observed adverse effect. It presents a moisturizing ability also.³¹ developed a herbal face pack with naturally available ingredients, claiming that the finished product was physiochemically and microbiologically stable and suitable for skincare.²³ developed a herbo-mineral scrub that was safe to use as a scrubbing/cleansing agent and had few negative effects because most of the ingredients were natural. As a result, the formulated laterite soil-based scrubbing effect herbal cleansing bar can provide the most satisfactory results, leaving the skin radiant and healthy.

4.3 Total Fatty Matter (TFM)

The TFM value of the product is 91.66 %. According to ISO Standards, TFM is above 76% is considered grade I soap, which has good quality. TFM above 60% has its place in grade II, and TFM above 50% fits into grade III soap. Most commercially available soaps are grade II or III, according to ³². ⁶ mentioned that higher TFM value soap is favorable for health and the environment. As a result, the designed herbs-mineral scrub effect soap bar can be classified as grade I soap and is suitable for use on the face.

4.4 Microbiological parameters and heavy metals

The total aerobic microbial count observed was lesser than 10 microorganisms per gram for the samples, which is lower than that recognized by Pharmacopoeias. The outcomes of the microbiological tests showed an absence of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans*, and *E-coli* as recommended by Pharmacopoeias ³³ which there is no

growth of colonies in VRBGA medium. Consumers may be exposed to health risks as a result of these items. ³⁴ showed that consumers in Europe are exposed to microbiologically contaminated and over-preserved cosmetics.

The concentrations of Pb, As, Hg, and Cd are not detected in formulated laterite soil-based scrubbing effect herbal cleansing bar. ³⁵ Showed that the greatest amounts of mercury and lead were found in well-known commercially available brands. ³⁶ indicate that the arsenic concentration of the lipsticks, eye shadows, and eyebrow pencils was much greater than the norms. Long-term use of heavy metal-containing items may result in an accumulation of heavy metals. Consumers' health may be harmed by the heavy metal availability in cosmetic items. Therefore, formulated herbs-mineral scrubbing effect cleansing bar is a safe product to use due to the absence of pathogenic microorganisms and heavy metals.

Table 2: Results for stability studies

Parameter	Initial	After 1 month of accelerated condition
Color	Reddish brown	Reddish brown
Odor	Characteristic pleasant order. free from off order	Characteristic pleasant order. free from off order
pH	7.9	7.9
Total aerobic mesophilic microorganisms	<10	<10
<i>Pseudomonas aeruginosa</i>	Absent	Absent
<i>Staphylococcus aureus</i>	Absent	Absent
<i>Escherichia coli</i>	Absent	Absent
<i>Candida albicans</i>	Absent	Absent

Table 3: Evaluation parameters

Parameter	Observation
Color	Reddish brown
Odor	Characteristic pleasant order
pH	7.9
Washability	Easily washable
Irritability	Non irritant
Total Fatty Matter (TFM)	91.66%
Total aerobic mesophilic Microorganisms	<10
Absence of pathogenic microorganisms	Absent
Heavy metals (As, Cd, Hg, Pb)	Not detected

CONCLUSIONS

The present study results concluded that new formulated herbs-mineral scrubbing effect cleansing bar could be safe for usage and the laterite soil used as a scrubbing and cleansing agent presenting decent sound effects and as more elements are natural ingredients, so probabilities for side effects are a smaller amount. It can be used for any skin, such as normal, oily, dry, and sensitive skin. It contributes the greatest results

and makes the skin shine and fine fettle, lacking any side effects.

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Conflicts of Interest

We certify that we don't have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

References

- Debbarma D, Moharana P, Mishra B, Ramana V, Dimple W. Clinical review of deep cleansing apricot scrub: an herbal formulation. *International Journal of Bioassay*. 2015; 4(9):4251-253.
- Okereke J, Udebuani A, Ezeji E, Obasi K, Nnoli M. Possible health implications associated with cosmetics: a review. *Science Journal of Public Health*. 2015; 3(5):58. <https://doi.org/10.11648/j.sjph.s.2015030501.21>
- Aglawe SB, Gayke AU, Khurde A, Mehta D, Mohare T, Pangavane A, Kandalkar S. Preparation and evaluation of polyherbal facial scrub. *Journal of Drug Delivery and Therapeutics*. 2019 Mar 15; 9(2):61-3. <https://doi.org/10.22270/jddt.v9i2.2380>
- Nemade CT, Baste N. Formulation and evaluation of a herbal facial scrub. *World J Pharm Res*. 2014; 3(3):4367-71.
- Curry A, McEween G. Quality assurance guidelines, evaluating new or revised products, CTFA technical guidelines, quality assurance guidelines. Washington: Cosmetic, Toiletry, and Fragrance Association. 1992.
- Betsy K, Jilu M, Fathima R, Varkey JT. Determination of alkali content & total fatty matter in cleansing agents. *Asian Journal of Science and Applied Technology*. 2013; 2(1):8-12.
- Behravan J, Bazzaz F, Malaek P. Survey of bacteriological contamination of cosmetic creams in Iran (2000). *International journal of dermatology*. 2005; 44(6):482-5. <https://doi.org/10.1111/j.1365-4632.2005.01963.x>
- Hugbo PG, Onyekweli AO, Igwe I. Microbial contamination and preservative capacity of some brands of cosmetic creams. *Tropical journal of Pharmaceutical research*. 2003; 2(2):229-34. <https://doi.org/10.4314/tjpr.v2i2.14604>
- Michalek I, John S, Caetano dos Santos F. Microbiological contamination of cosmetic products-observations from Europe, 2005-2018. *Journal of the European Academy of Dermatology and Venerology*. 2019; 33(11):2151-7. <https://doi.org/10.1111/jdv.15728>
- BAIRD RM. Bacteriological contamination of products used for skin care in babies. *International journal of cosmetic science*. 1984; 6(2):85-90. <https://doi.org/10.1111/j.1467-2494.1984.tb00362.x>
- Maier LE, Lampel HP, Bhutani T, Jacob SE. Hand dermatitis: a focus on allergic contact dermatitis to biocides. *Dermatologic clinics*. 2009; 27(3):251-64. <https://doi.org/10.1016/j.det.2009.05.007>
- Timm-Knudson VL, Johnson JS, Ortiz KJ, Yiannias JA. Allergic contact dermatitis to preservatives. *Dermatology nursing*. 2006; 18(2):130.
- Nnorom I, Igwe J, Oji-Nnorom C. Trace metal contents of facial (make-up) cosmetics commonly used in Nigeria. *African Journal of Biotechnology*. 2005; 4(10).
- Bocca B, Pino A, Alimonti A, Forte G. Toxic metals contained in cosmetics: a status report. *Regulatory Toxicology and Pharmacology*. 2014; 68(3):447-67. <https://doi.org/10.1016/j.yrtph.2014.02.003>
- Lim DS, Roh TH, Kim MK, Kwon YC, Choi SM, Kwack SJ, Kim KB, Yoon S, Kim HS, Lee BM. Non-cancer, cancer, and dermal sensitization risk assessment of heavy metals in cosmetics. *Journal of Toxicology and Environmental Health, Part A*. 2018 Jun 3; 81(11):432-52. <https://doi.org/10.1080/15287394.2018.1451191>
- Gunduz S, Akman S. Investigation of lead contents in lipsticks by solid sampling high resolution continuum source electrothermal atomic absorption spectrometry. *Regulatory Toxicology and Pharmacology*. 2013; 65(1):34-7. <https://doi.org/10.1016/j.yrtph.2012.10.009>
- Lundov M, Zachariae C. Recalls of microbiologically contaminated cosmetics in EU from 2005 to May 2008. *International journal of cosmetic science*. 2008; 30(6):471-4. <https://doi.org/10.1111/j.1468-2494.2008.00475.x>
- Mwambete K, Simon A. Microbiological quality and preservative capacity of commonly available cosmetics in Dar es Salaam, Tanzania. *East and Central African Journal of Pharmaceutical Sciences*. 2010; 13(1).
- Mitra S, Thakur LS, Rathore VK, Mondal P. Removal of Pb (II) and Cr (VI) by laterite soil from synthetic waste water: single and bi-component adsorption approach. *Desalination and Water Treatment*. 2016; 57(39):18406-16. <https://doi.org/10.1080/19443994.2015.1088806>
- Nayanthika I, Jayawardana D, Bandara N, Manage P, Madushanka R. Effective use of iron-aluminum rich laterite based soil mixture for treatment of landfill leachate. *Waste Management*. 2018; 74:347-61. <https://doi.org/10.1016/j.wasman.2018.01.013>
- Zhang L, Hong S, He J, Gan F, Ho Y-S. Adsorption characteristic studies of phosphorus onto laterite. *Desalination and Water Treatment*. 2011; 25(1-3):98-105. <https://doi.org/10.5004/dwt.2011.1871>
- Beauvais A. Geochemical balance of lateritization processes and climatic signatures in weathering profiles overlain by ferricretes in Central Africa. *Geochimica et Cosmochimica Acta*. 1999; 63(23-24):3939-57. [https://doi.org/10.1016/S0016-7037\(99\)00173-8](https://doi.org/10.1016/S0016-7037(99)00173-8)
- Mahajan S, Gayakwad D, Tiwari A, Darwhekar G. Formulation and Evaluation of Herbo-Mineral Facial Scrub. *Journal of Drug Delivery and Therapeutics*. 2020; 10(3):195-7. <https://doi.org/10.22270/jddt.v10i3.4039>
- Prathyusha J, Yamani N, Santhosh G, Aravind A, Naresh B. Formulation and Evaluation of Polyherbal Face Scrubber for Oily Skin in Gel Form. 2019. <https://doi.org/10.25004/IJPSDR.2019.110404>
- Itoh Y, Ninomiya Y, Tajima S, Ishibashi A. Photodynamic therapy of acne vulgaris with topical δ -aminolaevulinic acid and incoherent light in Japanese patients. *British Journal of Dermatology*. 2001; 144(3):575-9. <https://doi.org/10.1046/j.1365-2133.2001.04086.x>
- das Graças Silva-Valenzuela M, Chambi-Peralta MM, Sayegh IJ, de Souza Carvalho FM, Wang SH, Valenzuela-Díaz FR. Enrichment of clay from Vitoria da Conquista (Brazil) for applications in cosmetics. *Applied Clay Science*. 2018; 155:111-9. <https://doi.org/10.1016/j.clay.2018.01.011>
- Chauhan AS, Bhadauria R, Singh AK, Lodhi SS, Chaturvedi DK, Tomar VS. Determination of lead and cadmium in cosmetic products. *Journal of Chemical and Pharmaceutical Research*. 2010; 2(6):92-7.
- Dissanayake C. Mineralogy and chemical composition of some laterites of Sri Lanka. *Geoderma*. 1980; 23(2):147-55. [https://doi.org/10.1016/0016-7061\(80\)90016-6](https://doi.org/10.1016/0016-7061(80)90016-6)
- Benjamin MM, Sletten RS, Bailey RP, Bennett T. Sorption and filtration of metals using iron-oxide-coated sand. *Water research*. 1996; 30(11):2609-20. [https://doi.org/10.1016/S0043-1354\(96\)00161-3](https://doi.org/10.1016/S0043-1354(96)00161-3)
- Fonseca B, Maio H, Quintelas C, Teixeira A, Tavares T. Retention of Cr (VI) and Pb (II) on a loamy sand soil: kinetics, equilibria and breakthrough. *Chemical Engineering Journal*. 2009; 152(1):212-9. <https://doi.org/10.1016/j.cej.2009.04.045>
- Somwanshi SB, Kudale KS, Dolas RT, Kotade KB. Formulation and evaluation of cosmetic herbal face pack for glowing skin. *Int J Red*

- Ayurveda Pharm. 2017; 8(3):199-203.
<https://doi.org/10.7897/2277-4343.083199>
32. Mwanza C, Zombe K. Comparative Evaluation of Some Physicochemical Properties on Selected Commercially Available Soaps on the Zambian Market. Open Access Library Journal. 2020; 7(3):1-13. <https://doi.org/10.4236/oalib.1106147>
33. Pharmacopoeia U, editor 30/NF25. US Pharmacopoeial Convention, Rockville, MD; 2007.
34. Neza E, Centini M. Microbiologically contaminated and over-preserved cosmetic products according Rapex 2008-2014. Cosmetics. 2016; 3(1):3.
<https://doi.org/10.3390/cosmetics3010003>
35. Alizadeh A, Balali-Mood M, Mahdizadeh A, Riahi-Zanjani B. Mercury and lead levels in common soaps from local markets in mashhad, Iran. Iranian Journal of Toxicology. 2017; 11(4):1-3.
<https://doi.org/10.29252/arakmu.11.4.1>
36. Saadatzadeh A, Afzalan S, Zadehdabagh R, Tishezan L, Najafi N, Seyedtabib M, Noori SM. Determination of heavy metals (lead, cadmium, arsenic, and mercury) in authorized and unauthorized cosmetics. Cutaneous and ocular toxicology. 2019 Jul 3; 38(3):207-11. <https://doi.org/10.1080/15569527.2019.1590389>