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FORMULATION AND EVALUATION OF ECO-GLOW BODY SCRUB FROM SPENT COFFEE GROUNDS AND RICE POWDER

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ABSTRACT

The increasing demand for sustainable and natural cosmetic products has led to the utilization of biodegradable waste materials in personal care formulations. The present study was aimed at formulating and evaluating an eco-friendly body scrub using spent coffee grounds (*Coffea arabica*) and rice powder (*Oryza sativa*) as natural exfoliating agents. Shea butter, jojoba oil, tea tree oil and vitamin E were incorporated to enhance moisturizing, antimicrobial and antioxidant properties. Three formulations (F1–F3) were prepared and evaluated for organoleptic properties, and F3 was found to be superior to the other two due to its higher proportion of rice powder compared to coffee grounds and a greater amount of butter than oil compared with F1 and F2. The parameters such as pH, spreadability, washability, exfoliation efficacy (by the tape-stripping method), antioxidant activity (using the DPPH assay), grittiness, acid value and preservative efficacy was also compared. The formulations showed acceptable pH (6.2–6.8), good spreadability, easy washability and effective exfoliation. Antioxidant studies revealed significant free-radical scavenging activity. The study concludes that spent coffee grounds and rice powder can be successfully utilized to develop an effective, safe, and eco-friendly body scrub.

KEYWORDS: Eco-friendly cosmetics, Spent coffee grounds, Rice powder, Body scrub. Exfoliation.

INTRODUCTION

Cosmetics are products that are applied to the outer parts of the body to clean the skin, make it look better, and improve personal appearance. In recent years, many people have started preferring herbal and eco-friendly cosmetics because some synthetic ingredients used in regular cosmetics may cause skin irritation, allergies, or long-term side effects. Since the skin is the largest organ of the human body, it needs products that are mild, non-irritating, close to the natural pH of the skin, and safe for regular use as well as for the environment.

Exfoliation is an important part of skin care. It helps to remove dead cells from the outermost layer of the skin (stratum corneum), which makes the skin smoother, improves blood circulation, and allows creams and lotions to work better. Natural exfoliating materials such as spent coffee grounds and rice powder gently rub away dead skin without damaging healthy skin. In addition, coffee contains antioxidants that help to protect the skin from damage, while rice powder is known for its soothing and brightening effects. Using these natural and biodegradable materials not only benefits the skin but also reduces waste, making cosmetic products eco-friendlier and more sustainable.[1][2]

MATERIALS AND METHODS

The materials used were spent coffee grounds, rice powder, jojoba oil, shea butter, vitamin E and tea tree oil.

METHODS

Formulation of Eco-Glow Body Scrub from Spent Coffee Grounds and Rice Powder

Spent coffee grounds (SCG) are first collected and dried properly to remove all moisture. Rice is collected, washed thoroughly to remove dirt and impurities, dried,

and then ground into a fine powder. The rice powder is passed through a 60 or 70 mesh sieve to obtain uniform, smooth particles. The dried spent coffee grounds and sieved rice powder are then mixed well to form the exfoliating phase.

Jojoba oil and shea butter are taken as the base and melted together using a double-boiling method (placing the container in hot water) to avoid direct heat and prevent damage to the ingredients. After melting, the mixture is allowed to cool slightly. Vitamin E and the essential oil are then added and mixed well.

The powdered mixture of coffee and rice is slowly added to the oil base and stirred until a uniform scrub is formed. The prepared scrub is transferred into clean, sterilized, airtight containers. The containers are labelled and stored in a cool and dry place.

If a thicker and creamier scrub is needed, the amount of shea butter can be increased or 1–2% of candelilla wax or beeswax can be added. If a thinner and more fluid scrub is required, only oils can be used without adding butter or wax.[3]

EVALUATION

A. PHYSICAL PROPERTIES

Appearance, colour, odour and consistency were evaluated.

B. DETERMINATION OF pH

The pH of the formulated body scrub was measured using a digital pH meter at a constant temperature.[4]

C. SPREADABILITY

Spreadability test evaluates the spreading capacity of the scrub. About 1 g of scrub was placed between two glass slides. After 60 seconds, weights of 150 g and 200 g were applied. Spreadability was calculated using the formula.[4]

$$S = \frac{m \times l}{t}$$

S = Spreadability
m = Weight placed on slide
l = Length of glass slide
t = Time taken in sec

D. WASHABILITY

The washability of the scrub was examined by applying a small quantity of scrub on the albumin film and washing with water, then noting the result.[5][6]

E. EXFOLIATION EFFICACY TEST

Exfoliation Efficacy Test (Tape Stripping Method)

The exfoliation efficiency of the formulation is evaluated using the tape-stripping method. This is a simple and effective technique to check how well a cosmetic or skin-care product removes dead skin cells. In this method, adhesive tape is applied to the treated skin surface and then gently removed. The amount of protein (albumin) collected on the tape shows how many dead skin cells have been removed. By analysing the protein present on a series of tape strips, it is possible to understand how deeply and effectively the scrub removes the outer layer of dead skin (artificial stratum corneum).[7][8]

F. EVALUATION OF BASE

Acid Value

The acid value of jojoba oil is very low, which shows that it is of good quality and stable. A low acid value means that very few free fatty acids are present, indicating that the oil has not undergone rancidity. This makes jojoba oil suitable for use in cosmetic and skin-care products, as it is gentle on the skin and has a long shelf life.[9]

Acid value= (56.1 x V x N)/W

V= Volume (in mL) of the standard alkali used for titration.
N= Normality of the standard alkali solution.
56.1=A constant representing the molecular weight of KOH in milligrams per milliequivalent. W= Weight of the oil or fat taken for analysis

G. GRITTINESS/PARTICLE SIZE

Particle grittiness is tested by microscopic method, which involves preparing a slide sample and observing it under microscope to assess the shape, size and distribution of abrasive particles. The observation results in qualitative or semi- qualitative descriptions of grittiness or uniformity of content in the formulation. This information helps to ensure the formulation meets the desired texture and safety standards.[10]

H. ANTIOXIDANT PROPERTY

The DPPH assay is a simple test used to check the antioxidant activity of a substance. DPPH (2,2-diphenyl-1-picrylhydrazyl) is a stable free radical that has a deep purple colour. When an antioxidant is added to a DPPH solution, it donates a hydrogen atom to the DPPH radical. This reaction reduces DPPH and changes its colour from purple to yellow.

The change in colour is measured using a spectrophotometer at a wavelength of about 515 nm. The greater the colour change, the stronger the antioxidant activity of the sample. This method is widely used because it is simple, quick, and gives reliable information about the free-radical scavenging ability of cosmetic and herbal formulations.[11]
Where;

$$\% \text{ Inhibition} = \frac{(A_C - A_s)}{A_C} \times 100$$

A c = Absorbance of control
A s = Absorbance of sample

I. PRESERVATIVE EFFICACY TEST

The preservative efficacy test for a scrub is carried out using a challenge test. In this test, the product is

deliberately mixed with known microorganisms, and the number of microbes is measured over a period of 28 days. This test helps to check whether the preservative present in the scrub is strong enough to keep the product safe during normal storage and use.

A small amount of the prepared scrub is taken in a sterile container. Known strains of bacteria and fungi are added to it. The sample is then stored under controlled conditions. At fixed time intervals such as 7, 14, and 28 days, a small portion of the scrub is tested to find out how many microorganisms are still alive.

If the preservative is effective, the number of microorganisms will decrease over time and no new growth will be seen. For the scrub to pass the test, there must be a clear reduction in microbial count and no regrowth of microorganisms during the test period. This confirms that the product is safe for regular use.[12]

RESULT AND DISCUSSION

Formulated body scrub;

Three formulations F1, F2 and F3 of body scrubs were prepared and evaluated. Different formulations were prepared by adjusting the consistency of the product, which is achieved by altering the volume of oil and butter in each formulation.

The photographs of formulated body scrubs are shown below.

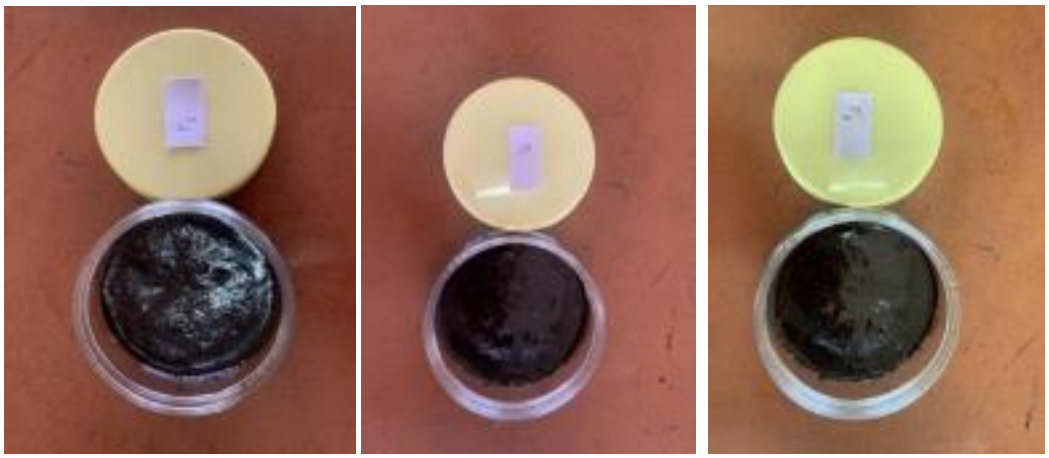


Fig 1: The photograph of prepared Body Scrubs, F1 F2 F3.

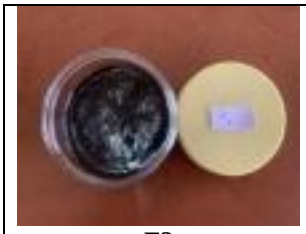
Among the prepared formulations, F3 was found to be the best, as it exhibited ideal scrub properties, providing smooth and moisturizing exfoliation due to a higher proportion of rice powder compared to coffee grounds and a greater amount of butter than oil.

1. PHYSICAL EXAMINATION

The formulated body scrubs were evaluated for their colour, odour and texture using simple visual and sensory examination. Each formulation was carefully observed for appearance and uniformity, while the smell was checked to ensure it was pleasant and free from any unwanted or rancid odour. The texture was assessed by gently rubbing a small amount between the fingers to confirm smoothness, consistency and the absence of lumps or excessive grittiness. These observations help to judge the overall acceptability and quality of the prepared formulations. The results of these evaluations are presented below.

Table no.1: Physical evaluation of formulated body scrub.

Formulation	Colour	Odour	texture
 **F1**	Dark brown	Characteristic	Gritty

 **F2**	Dark brown	Characteristic	Gritty
 **F3**	Dark brown	Characteristic	Less Gritty

2. DETERMINATION OF pH

The pH of prepared formulations was determined using pH digital meter and pH values are shown table no:2.

Table no.2: pH of formulated body scrub.

Formulation	pH
F1	5.2±0.02
F2	5.8±0.02
F3	5.4±0.04

All values are expressed as a mean of ±SD, n=3.

The pH of the formulated body scrub was found to be in the ideal pH range for the body scrub that is between 5-6.

3. SPREADABILITY

Table no.3: Spreadability of formulated body scrub.

FORMULATION	SPREADABILITY (gm.cm/sec)
F1	6.25±0.05
F2	5.94±0.07
F3	6.83±0.05

All values are expressed as a mean of ±SD, n=3.

The Spreadability study indicated that the formulated body scrub exhibited satisfactory Spreadability which is crucial for ensuring uniform application and coverage on skin.

4. WASHABILITY

Washability test was carried out by applying a small amount of scrub on albumin film and washing with tap water. All three formulations were easily washable.

5. EXFOLIATION EFFICACY TEST

Microscopic evaluation of body scrub using tape stripping method generally indicates that the scrub provides a mild to moderate exfoliation efficacy.

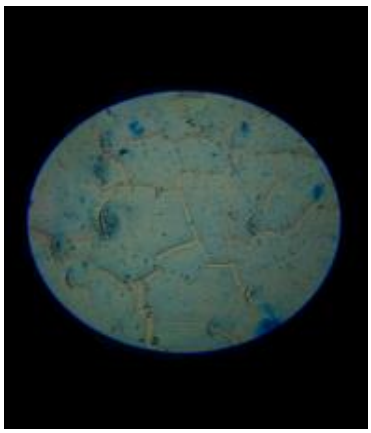


Fig 2: Microscopic view of stripped tape on control.

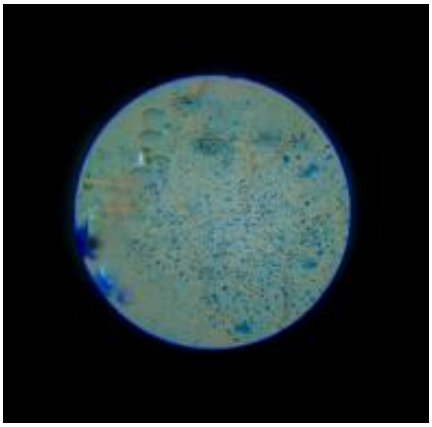


Fig 3: Microscopic view of stripped tape on test.

The exfoliation efficacy of the test scrub was evaluated using the tape stripping method followed by staining and microscopic observation. Upon microscopic visualization, the test sample showed higher stain density on the tape strips compared to the control sample. The test sample showed significantly higher protein removal compared to control, confirming better exfoliation efficiency.

6. EVALUATION OF BASE

ACID VALUE

The acid value of the oil base used in the formulated body scrub was found to be **1.59 ± 0.45**, which is within acceptable limits. This low acid value indicates that the oil base is of good quality and has not undergone significant degradation or rancidity. It also suggests good stability of the formulation, making it suitable for use in cosmetic preparations.

7. GRITINESS/PARTICLE SIZE

The grittiness of the body scrub is evaluated to ensure that it provides mild abrasion to remove dead skin without causing irritation. This test helps confirm that the particles are not too large or sharp but are effective enough to give proper exfoliation, resulting in smooth and soft skin. In this study, grittiness was assessed using the microscopic method.

Fig 4: Microscopic view of particles in Body Scrub.

8. ANTIOXIDANT PROPERTY

Antioxidant activity is the ability of a compound or an extract to inhibit oxidation reaction which can be expressed by the presentation of DPPH absorption. The antioxidant activity of spent coffee powder was studied to assure the activity of prepared body scrub.

Table no.4: Antioxidant activity of spent coffee powder.

Concentration(µg/ml) Coffee Powder	%inhibition	Concentration(µg/ml) Ascorbic acid	%inhibition
50	22%	50	54%
100	40.2%	100	81.4%
150	54.8%	150	89.2%

All values are expressed as a mean of ±SD, n=3.

9. PRESERVATIVE EFFICACY

Table no.5: log reduction table.

Test microorganisms	Initial count	Day7 (CFU/g)	Day14 (CFU/g)	Day28 (CFU/g)	Log reduction	Result
Staphylococcus aureus	1.2×10^{5}	3.6×10^{3}	1.1×10^{2}	<10	≥ 4	Pass
Escherichia coli	1.1×10^{5}	4.1×10^{3}	9.5×10^{1}	<10	≥ 4	Pass
Pseudomonas aeruginosa	1.3×10^{5}	5.2×10^{3}	1.4×10^{2}	<10	≥ 4	Pass
Candida albicans	8.5×10^{4}	2.8×10^{3}	1.2×10^{2}	<10	≥ 3	Pass
Aspergillus niger	9.0×10^{4}	3.4×10^{3}	1.6×10^{2}	<10	≥ 3	Pass

The preservative efficacy test showed a strong and consistent reduction in all the tested microorganisms over the 28-day period. Bacterial strains such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* showed a log reduction of 4 or more, while fungal strains such as *Candida albicans* and *Aspergillus niger* showed a log reduction of 3 or more, which meets the acceptable limits for cosmetic products. By Day 28, the microbial counts for all organisms were reduced to less than 10 CFU/g, indicating effective control of microbial growth. These results confirm that the preservative system used in the body scrub is effective in preventing microbial contamination and ensuring the product remains safe and stable during storage and normal use.

CONCLUSION

Natural and eco-friendly cosmetic products are increasingly preferred because they are safer, more sustainable, and cause fewer side effects. In the present study, an eco-friendly body scrub named EcoGlow was formulated and evaluated using spent coffee grounds and rice powder as the main natural ingredients. These materials not only help in utilising biodegradable waste but also provide useful cosmetic benefits such as exfoliation, skin brightening, and antioxidant activity. The formulation was easy to prepare using simple laboratory procedures and showed acceptable colour, pleasant odour, and a smooth, uniform texture.

The scrub showed acceptable pH, spreadability, washability, grittiness, antioxidant activity and preservative efficacy. The results showed that the product had a skin-friendly pH, good spreadability, easy washability, and a smooth feel on application. The presence of spent coffee grounds provided effective

exfoliation and strong antioxidant activity, while rice powder contributed to smoothness and a mild skin-brightening effect. The preservative efficacy study also confirmed that the product was microbiologically safe and stable during storage.

Based on the overall evaluation results, it can be concluded that the formulated EcoGlow body scrub is effective, economical and environmentally friendly. The study clearly shows that spent coffee grounds and rice powder can be successfully used to develop a natural cosmetic product, supporting the use of biodegradable waste materials for sustainable and eco-friendly cosmetic formulations.

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