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Original Research Article

Formulation and evaluation of anti-tanning soap by using millets

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Abstract

Introduction: The formation of melanin from extended sun exposure results in tanning, which increases the demand for safe, natural skincare treatments. Millets might be able to prevent tanning because of their high vitamin, phenolic chemical, and antioxidant content. In this work, their incorporation into soap compositions is examined to enhance dermatological advantages.

This study aimed to develop and evaluate an anti-tanning soap using millets. This study looked into the idea of incorporating millet powders or extracts into a soap base to produce a product that might reduce skin darkening. After formulation, the soap was assessed based on many standards.

Materials and Procedures: A cold process method was used to make the soap, which included millet extract (either pearl millet or foxtail), base oils (olive, coconut), sodium hydroxide, and other natural ingredients (turmeric, honey). The physicochemical characteristics (pH, hardness, and foam retention), stability, antioxidant activity (DPPH assay), and anti-tanning effectiveness (tyrosinase inhibition assay) of the prepared soap were assessed.

Results: The millet-based soap demonstrated considerable tyrosinase inhibition (≥60%), high lather stability, and a desired pH (8–9), all of which suggested anti-tanning potential. Stability studies verified that there was little degradation, and antioxidant activity was noteworthy (≥70% DPPH scavenging). Improved skin texture and less tanning were observed by users.

Conclusion: The study used millets to successfully create an anti-tanning soap that showed promise as an antioxidant and skin-lightening agent. This natural mixture deserves more clinical validation because it offers a sustainable substitute for synthetic anti-tanning solutions.

Keywords: Anti-tanning, Formulation, Evaluation, Millets, Skin hydration, Anti-bacterial, Antifungal properties

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1. Introduction

An ancient grain that is valued for both its nutritional value and historical significance, milletis a mainstay in the diets of many cultures worldwide. For thousands of years, this diversified group of small-seeded grasses has supported civilizations due to its ability to withstand difficult growing circumstances. Each of the many types of millets—including ragi, bajra, foxtail, kodo, and others—has distinct qualities and nutritional profiles. These grains are becoming a major topic in conversations about sustainable and healthful diets, in addition to providing food for people in semi-arid parts of Asia and Africa. Because of their remarkable health benefits, resilience, and cultural significance, millets continue to draw attention, from their vital role in traditional cuisines to their rebirth in contemporary nutrition. The purpose of this introduction is to examine the nutritional value, historical background, and worldwide relevance of millets in order to highlight their many benefits for human health and sustainable food systems.

2. Materials and Methods

1.1. Types of millets and their benefits

The ancient grain known as sorghum (Sorghum bicolor) has been grown for ages in Africa and India. It is renowned for its nutritional value and is a staple crop in these areas. For those who are gluten intolerant or have celiac disease,

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sorghum is regarded as a safe food grain substitute. It is simple to incorporate into your diet and is high in natural nutrients. Sorghum is also a popular natural and affordable fuel source and animal feed. Sorghum is high in vitamins and minerals and devoid of gluten. It is abundant in antioxidants and contains a significant amount of dietary fiber. It is a great source of antioxidants and dietary fiber. Sorghum inhibits tumor growth, is a natural treatment for diabetes, decreases blood cholesterol, aids in weight control, builds strong bones, elevates mood, increases vitality, and improves blood circulation.

1. **Finger millet (Eleusine coracana):** Also referred to as ragi, finger millet is a tasty, healthy cereal that is simple to prepare. It is abundant in calcium, iron, fiber, protein, and other vital minerals. 10. One of the healthiest millets in the world, finger millet is low in fat and gluten. Additionally, it has been shown to improve cardiovascular health, slow down aging, lower the risk of heart disease, strengthen bones, manage diabetes, and provide antioxidant properties that help prevent harm from free radicals.

2. Proso millet (Panicum miliaceum): Known by several names, including white millet, hog millet, or Kashif millet, this nutrient-dense cereal is grown and eaten extensively in India. Due to its numerous health advantages, it is marketed as a health food. Niacin (often called vitamin B3) is abundant in proso millet. Skin conditions like pellagra, which produces dry, scaly, and rough skin, can result from a lack of niacin, which is necessary for healthy skin. The high niacin content of proso millet helps keep skin healthy and prevent pellagra.

3. Foxtail Millet (Setariaitalica): Known by many as kangni, foxtail millet is a very nutrient-dense cereal that is consumed extensively in India and other countries. is well-known for its numerous health advantages and makes an excellent alternative to rice. Essential elements like carbohydrates, dietary fiber, protein, vitamins (especially B12 vitamins), and minerals (such as iron, calcium, and magnesium) can all be found in good amounts in foxtail millet.

4. Pearl millet (Pennisetum glaucum): In India and other countries, pearl millet, often called bajra, is a popular and nutrient-dense cereal. It contains a lot of magnesium, which is proven to lessen migraine frequency and asthma severity. An important mineral, magnesium is necessary for numerous body processes, such as blood sugar balance, blood pressure control, and muscle and neuron function.

5. Kodo millet (Paspalum scrobiculatum): Kodo millet, sometimes referred to as arke or kodra, is a very nutrient-dense crop that is consumed in large quantities in India and other countries. It is abundant in phytochemicals and antioxidants and makes a fantastic rice alternative. Kodo millet is an excellent source of nutritional and other vital elements.

2.2. Benefits of millets for health:

Millets are very nutrient-dense and offer a number of health advantages. Here is a list of small millet's nutritional information. When taken regularly, it helps regulate blood sugar levels. It demonstrated increased HDL cholesterol and decreased LDL/VLDL cholesterol and triglyceride levels. Compared to rice, it has a low glycemic index, which causes a slow rise in blood sugar levels after meals. Ideal diet for those with gastric issues and diabetes. Cut down on the chance of a heart attack. Aids in the growth of body tissue and the metabolism of energy. Plenty of antioxidants.[1-2] The skin is the largest body organ and is the shield between the external world and the internal organs. It contributes significantly to homeostasis and health in general. You might not always consider the skin an organ, but it is indeed composed of tissues that act together as one structure to carry out special and essential functions. The accessory structures and the skin together constitute the integumentary system, which gives the body general protection. The skin consists of several layers of tissues and cells and is attached to underlying structures through connective tissue.[3] The deeper layer of skin is rich in blood vessels. It contains many sensory, as well as.

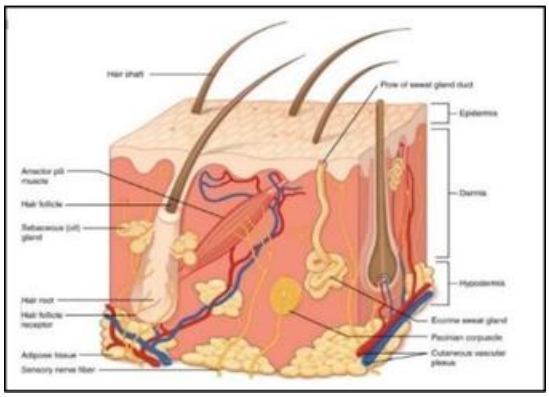

Figure 1

Autonomic and sympathetic nerve firestone sure communication to and from the brain. The different types of skin are;

1. Normalskin
2. Dryskin
3. Oily skin Combinationskin

2.3. Herbal soap

Herbal soap is a natural substitute for traditional soap that is normally produced using herbal botanicals and plant-derived ingredients. The increasing popularity of herbal soap is due to its friendly skin properties. Since herbal soaps are free from chemicals and synthetic fragrances, these soaps are especially suitable for people with sensitive skin. In addition, their natural ingredients make them an environmentally friendly option, attracting those who want a greener and more gentle personal care alternative. It is created with natural ingredients that are not harmful tothe environment and are biodegradable. The application of herbs in herbal soap yields numerous benefits, including healing and soothing the skin, giving a natural scent, and eliminating stress and anxiety with aromatherapy. The herbal ingredients used in herbal soap have antibacterial, antifungal, and anti-inflammatory effects, making them useful in treating several conditions of the skin such as acne, eczema and psoriasis.[3] Herbal soap is available in different scents and preparations, making it simple to choose one that caters to your specific needs. Some of the widely used herbs for herbal soap are lavender, chamomile, peppermint, rosemary, lemongrass, tea tree, calendula, oatmeal, aloe vera, clove, neem, turmeric, sage, and comfrey. Each herb possesses special properties which is good for the skin as well as the overall health. Due to increased awareness about synthetics and chemicals, herbal soap is becoming more popular as an eco-friendly, safe, and healthy option for personal care. They provide avariety of benefits to the skin because they contain natural ingredients.

2.4 Preparation of herbal powders:[4-5]

1. Millets powder: Allthemilletsaretakenintheratioof1: 1ratioandaccuratelyweighedby using digital balance.
2. The composition was readily available in the market in the powder form, was taken and used in the formulation
3. Sandal powder: The sandal wood piece was taken and grinded into the powder and sieved into smooth talk.
4. Charcoal powder: The charcoal is collected from market. It was grinded into the fine particles of powder form.
5. Neem powder: The fresh leaves are collected and dried under the sunlight for 2 to 3 days. After drying the neem leaves are grinded into the powder and collected into a jar.
6. Hibiscus powder: The fresh hibiscus leaves and flowers are collected and dried it under the sunlight for 2 to 3 days. After drying these are grinded into the powder and collected into a jar.(**Figure 2**)

Figure 2:

Table 1: Ingredients of millets

S. No.	Name of Millets	S.No.	Name of Millets
1.	Almond	9.	Barley
2.	Redrice	10.	Cerealgrain oat
3.	Rajma	11.	Soyabeans
4.	Flaxseeds	12.	Blackeyed peas
5.	Kalonji seeds	13.	Wheat
6.	Foxtail millets	14.	Pearl millet
7.	White sesame	15.	Peanut
8.	Cashew nut	16.	Barnyard millets

Table 2:

S. NO.	Ingredients	Purpose
1	Millets powder	Reduce inflammation, improving hydration, and promoting skin repair
2.	Capra aegagrus hircus (goat) milk	Exfoliate, soften, brighten, and smooth the skin
3.	Sandal powder	Anti-aging, Skin brightening, Treat blemishes, Anti- bacterial
4.	Charcoal powder	Deep cleansing, treating acne, Reducing the appearance of pores
5.	Coconut oil	Moisturizer, anti-oxidants, brightens skin, anti-aging
6.	Rose oil	Anti-inflammatory, Antioxidant, reduces wrinkles, Enhances skin elasticity
7.	Methyl paraben	Preservative
8.	Soap base	Saponification, Micelle formation, Cleansing action
9.	Neem	Anti-microbial, Anti-bacterial, Anti-oxidant

10.	Hibiscus	Skin nourishment, Anti-inflammatory, Anti-oxidant

Table 3: Formulation of soap:[6]

S. NO.	Ingredients	F1	F2	F3	F4	F5	F6
1	Millets powder	5%w/w	10%w/w	15%w/w	_	_	_
2.	Capra aegagrus hircus (goat) milk	5%v/v	10%v/v	15%v/v	_	_	_
3.	Sandal powder	1%w/w	2%w/w	3%w/w	_	_	_
4.	Charcoal powder	0.5%w/w	1%w/w	2%w/w	_	_	_
5.	Neem	_	_	_	5%w/w	10%w/w	15%w/w
6.	Hibiscus	_	_	_	5%w/w	10%w/w	15%w/w
7.	Coconut oil	_	_	_	1.5%w/v	1.5%w/v	1.5%w/v
6.	Rose oil	1%w/v	1%w/v	1%w/v	1%w/v	1%w/v	1%w/v
7.	Methyl paraben	0.5%w/w	0.5%w/w	0.5%w/w	0.5%w/w	0.5%w/w	0.5%w/w
8.	Soap base	Up to 100gms	Up to 100gms	Up to 100gms	Up to 100gms	Up to 100gms	Up to 100gms

3. Preparation of Millets Soap

Take the mortar and pestle and add the millets powder, sandal powder, charcoal powder into it. And Triturate it vigorously without any presence of granules. Now Add the coconut oil and rose water and methyl paraben and triturate until it mixed well. Boil the goat milk in a beaker and pour into the mixture. Melt the soap base in double boiling process. Mix the soap base and the mixer and pour it into the soap moulds and let it dry for some time.

4. Preparation of Neam Soap

Take the mortar and pestle and add the neem powder, hibiscus powder into it. Triturate vigorously without any presence of granules. Now add the coconut oil and rose oil and triturate until mixed well. Now add the methyl paraben for preventing microbial growth. Melt the soap base in double boiling process. Finally add the mixture into the soap base mix it well and pour into the moulds. Wait for 5mins and take out the soap.

5. Evaluation Parameters of Herbal Soaps

5.1. Organoleptic evaluation

The color and state of the prepared soap were examined by physical appearance for organoleptic evaluation.[7]

5.2. Appearance

The soap should have a uniform and smooth surface without cracks, discoloration, or air bubbles.

1. **Color:** The color was observed to be consistent and uniform throughout the soap bar or liquid.
2. **Odor (Fragrance):** The fragrance should be pleasant, consistent, and not over powering. It should match the intended scent profile.
3. **Shape:** Evaluation of organoleptic properties, such as shape and clarity, was carried out by sensory and visual examination.
4. **Texture (Touch and Feel):** The soap should have asmooth, non-sticky, and non-gritty feel. It should not feel overly greasy or excessively dry. Good-quality soap should not leave an unpleasant residue on the skin.
5. **Lathering Ability:** The soap should produce a sufficient amount of lather when rubbed with water. The foam should be creamy and stable, not too bubbly or too weak.
6. **Hardness (for Bar Soap):** The bar should be firm enough to hold its shape and not become too soft when exposed to water. Excessive hardness may make it difficult to use, while too soft a texture may cause wastage.
7. **After-Feel (Post-Wash Sensation):** The soap should rinse off easily without leaving a sticky or greasy residue. The skin should feel clean, fresh, and moisturized (not excessively dry or tight)

pH TEST (pH Meter, pH Test Strips): 10 gm of sample of soap was taken and dissolved it into 100ml distilled water. The pH solution was measured by standardized digital pH meter.[8]

1. **Foam Retention** (**Measuring Cylinder or Graduated Test Tubes, Measuring Scale or Ruler**): In this method, 1% quantity of soap solution is

prepared by dissolving in 20ml of distilled water. The solution is then agitated manually by shaking in a measuring cylinder, to generate foam. The initial foam height is recorded immediately after agitation, and the solution is left undisturbed for a set period, typically 5 to 10 minutes. After the specified time, the remaining foam height is measured to determine the foam retention capacity. A higher foam retention indicates better lather stability, which is a desirable property in soaps as it ensures effective cleansing and user satisfaction. This test is essential in soap quality control to ensure that the product performs well under typical usage conditions.[9]

2. **Foam Height (Electronic Balance, Measuring Cylinder or Graduated Test Tubes (with stoppers)):** 0.5gm of the sample of soap was taken and dispersed in 25 ml of distilled water. Then, transferred itinto100ml measuring cylinder; the volume was made up to 50 ml with water. 25 strokes were given and stand till aqueous volume was measured up to 50 ml and measured the foam height. Foam height is increased then total foam height is measured.[10]

3. **Washability (Soap Solution):** Wet hands with water and apply enough soap to cover all the hand surfaces and then rub the hands palm to palm, rinse hands with water and dry thoroughly with a single use towel. check whether the hands are perfectly cleaned or not.[11]

4. **Skin Irritancy Test (Test Patches, Sodium Lauryl Sulphate (SLS)):** Mark an area (2sq.Cm) on the right-hand dorsal surface. The herbal soap was applied to the right-hand side at the specified area at that time note what. Happened to the hand. Irritancy, Erythema, and Edema were checked for regular intervals up to 24 hours and then reported.[12]

5. **Determination of Moisture Content:** About 10g of the sample under study were accurately weighed and transferred to a tarred China dish of known weight and kept in a hot air oven at 100 – 105°C for an hour. Then, the sample was weighed along with the China dish to deduct the actual weight of tarred China dish. The weight of the content was noted to calculate the percentage moisture content.[13]

5.1. Formula

Moisture content=(Difference in weight/initial weight)x100

5.2. Antimicrobal test

In this study, the antimicrobial potential is presented in areas of growth inhibition, where the test microorganism is inoculated on a plate containing a solid culture medium. The product ofinterest is arranged at equidistant points on this same plate with the aid of a glass cylinder and, after incubation for 24 hours, it is observed whether there has been a growth inhibition halo around the substances.[14]

6. Evaluation Parameters Herbal Soaps

To evaluate the prepared formulations, quality control tests including visual assessment and physico-chemical controls such as pH, washability, hardness, lathering ability, texture, foam volume, foam stability and wetting time were performed using standard protocols.

6.1. Physical appearance

As any other herbal cosmetic products, the attractiveness of soaps for consumers tends to be judged visually, thus having good physical appearance is important. **(Figure 3)**

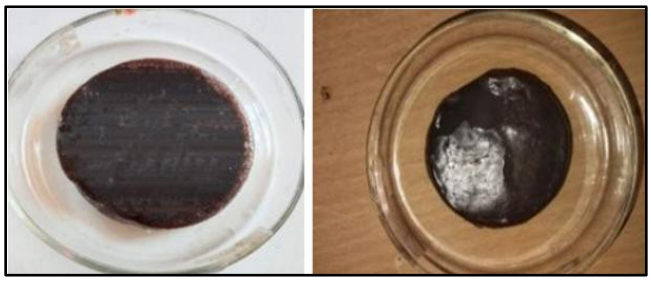

Figure 3:

6.2. Millet soap sample

Table 4:

S. No.	Characteristics	F1	F2	F3	F4	F5	F6
1.	Appearance	Solid	Solid	Solid	Solid	Solid	Solid
2.	Colour	Brown	brown	black	green	Dark green	Dark green
3.	odors	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
4.	Shape	Round	Round	Round	Square	Square	Square

Table 5:

S.No.	Properties	F1	F2	F3	F4	F5	F6
1.	Texture	Smooth andnon-sticky	Smooth andnon-sticky	Smooth andnon-sticky	Smooth and non-sticky	Smooth and non-sticky	Smooth andnon-sticky

2.	Latheringability	Creamy and stable	Creamy and stable	Creamy and stable	Creamy and stable	Creamy and stable	Creamy and stable
3.	Afterfeel	Clean, moisturized and tan removal	Clean, moisturized and tan removal	Clean, moisturized and tan removal	Clean, moisturized and tan removal	Clean, moisturized and tan removal	Clean, moisturized and tan removal
4.	Hardness	Firm	Firm	Firm	Firm	Firm	Firm

6.3. pHTEST

The pH range of the soap should be in 6-9 based on the type of usage.

1. Dissolve approximately1gram of soap in100ml of distilled water. Stir until completely dissolved.
2. Use the acid, base litmus papers for determining its nature.
3. For knowing the exact value of pH, the pH meter should be used by dipping the electrode into the soap solution.[2]

6.4. Foamheight test

1gm of soap sample is added to the distilled water and transformed it into the 100ml measuring cylinder and then make up to the 20ml. Measure the sample solution height using a measuring point on the cylinder and note its initia height. The solution is then agitated manually by shaking in a measuring cylinder, to generate foam. Later note the measuring point how foam does it produced.[7] Before after the initial height of the sample. 3cms. After the agitation the foam heights was reaches to 42ml of height where it measuresas10 cm. This test shows the soap sample has the good foaming ability.

6.5. Foam retention

In this method, 1% quantity of soap solution is prepared by dissolving in 20ml of distilled water. The solution is then agitated manually by shaking in a measuring cylinder, to generate foam. The initial foam height is recorded immediately after agitation, and the solution is left undisturbed for a set period, typically 5minutes. After the specified time, the remaining foam height is measured to determine the foam retention capacity.[9]

6.6. Formula

Foam Stability (%)=(Foam height after time / initial foam height)100 The initial height of the foam is 6.3cm. The final height of the foam after 5minutes is 6.4cm.

1. The foam retention percentage is1.56%
2. Interpretation: The soap retains 98.44 % of its foam, it indicates good quality with excellent foam stability.

6.7. Wash ability test

This test was conducted by wetting the hands with water and apply enough soap to cover all the hand surfaces and then rub the hands palm to palm, rinse hands with water and dry thoroughly with a single use towel. Check whether the hands are perfectly cleaned or not.[9]**Figure 4**

Figure 4

6.8. Skin irritation test

This test was observed by applying the sample soap on the skin near to the hands and allow it for some time and observes its changes is there any presence of irritancy or edema.[9]

The skin doesn't show any reaction where it is shows the skin smoothening and hydration.

Doesn't show any irritancy or edema on the skin.

Determination of Moisture Content: About 10g of the sample under study were accurately weighed and transferred to a tarred China dish of known weight and kept in a hot air oven at 100 – 105°C for an hour. Then, the sample was weighed along with the China dish to deduct the actual weight of tarred China dish. The weight of the content was noted to calculate the percentage moisture content.[9]

6.9. Formula

Moisture content= (Difference in weight/ initial weight) x100

1. The initial weight of the sample is10gms
2. The final weight of the sample is8.65gms
3. The moisture content of the soap is13.5 %.

6.10. Anti-microbial test

In this study, the antimicrobial potential is presented in areas of growth inhibition, where the test microorganism is inoculated on a plate containing a solid culture medium. The product of interest is arranged at equidistant points on this same plate with the aid of a glass cylinder and, after incubation for 24 hours, it is observed whether there has been a growth inhibition halo around the substances.[9]**Figure 5**

Table 6:

S. No.	Evaluation Tests	F1	F2	F3	F4	F5	F6
1.	Physical appearance test	brown	brown	black	green	Dark green	Dark green
2.	Ph test	7.04	7.5	7.8	6.8	6.7	6.9
3.	Foam height test	9.3cm	10cm	9cm	9.4cm	9.8cm	9.5cm
4.	Foam retention test	2%	1.5%	1.8%	3%	2.5%	2.3%
5.	Wash ability test	Easily washable	Easily washable	Easily washable	Easily washable	Easily washable	Easily washable
6.	Skin irritancy test	No irritancy or edema is observed	No irritancy or edema is observed	No irritancy or edema is observed	No irritancy or edema is observed	No irritancy or edema is observed	No irritancy or edema is observed
7.	Deter inaction of moisture content	10%	13.5%	11%	12%	14%	13.1%

Figure 5:

7. Results and Discussion

Millets have been found to contain a variety of flavonoids, including catechins and flavones, tannins, and phenolic compounds, including ferulic acid, p-coumaric acid, and caffeic acid. In vitro studies have shown that a number of these substances exhibit tyrosinase inhibitory action. Some phenolic acids, for example, have the ability to function as competitive inhibitors by attaching to the tyrosinase's active site and blocking the binding of the substrate (L-tyrosine). By chelating copper ions, which are necessary cofactors for tyrosinase, flavonoids can also have inhibitory effects.The primary cause of tanning is the skin's melanocytes' increased synthesis of the pigment melanin. The main rate-limiting enzyme in this sequence of enzymatic processes, known as melanogenesis, is tyrosinase. Tyrosinase activity can be inhibited by specific bioactive substances, which lowers the formation of melanin.Finally we discussed about The tyrosinase inhibitory activity of the identified phenolic and flavonoid compounds present in the millet extracts can be attributed to a significant decrease in melanin content in your evaluation models (such as in-vitro cell-based assays or possibly in-vivo studies) caused by your soap formulation containing millet extracts. You can reference research that has shown comparable effects for these particular substances.

8. Conclusion

We concluded that the millets soap renders the better outcome in tan removing and softens the skin hydration by giving the skin glow. The goat milk makes the smoothness to the skin and hydrated it. The charcoal brings the dirt removal from the skin. The sandal wood serves to make the skin glowing. Lastly, the millets create the tan removing from the skin by the production of collagen from skin that aids to enhance the skin color. Finally, the studies of evaluation revealed good results of appearance, wash ability, non-irritant to the skin, foam stability, dirt dispersion activity, anti-microbial activity, moisture content test.

In comparison to all the formulations, the millets soap F2 formulation qualifies in all the tests with the good standardof results. It indicates the good quality and purity in its formulation.

9. Source of Funding

None.

10. Conflict of Interest

None.

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