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FORMULATION PERSPECTIVES AND PHYTOCHEMICAL INSIGHTS INTO TRI-HERBA GMC: A POLYHERBAL COSMETIC SOAP

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ABSTRACT

Herbal soaps are increasingly preferred due to concerns about skin irritation and long-term effects associated with synthetic chemicals used in many commercial cleansing products. This review aims to summarize scientific evidence supporting the development of a tri-herbal cosmetic soap formulated using guava leaves (*Psidium guajava*), manjistha roots (*Rubia cordifolia*), and cucumber peel (*Cucumis sativus*). Relevant literature related to soap chemistry, skin structure, herbal extraction methods, polyherbal formulation approaches, and evaluation parameters was reviewed. Published studies describing the phytochemical composition, pharmacological activities, and dermatological applications of the selected plant materials were analyzed. The findings indicate that guava leaves possess antimicrobial, antioxidant, and wound-healing properties, manjistha exhibits detoxifying, anti-inflammatory, anti-acne, and skin tone–improving effects, and cucumber peel provides hydrating, cooling, soothing, and antioxidant benefits. When combined in a soap base, these herbs are expected to provide gentle cleansing along with protection against oxidative stress, microbial growth, inflammation, and skin irritation. Common evaluation parameters for polyherbal soaps include pH, foam characteristics, total fatty matter, antimicrobial activity, phytochemical

screening, and skin irritation testing. Overall, this review provides a concise scientific basis for the formulation of a tri-herbal cosmetic soap and supports the potential of polyherbal soaps as safe, effective, and natural alternatives to conventional soaps, forming a foundation for future experimental development of the TRIHERBA GMC formulation.

KEYWORDS: Polyherbal soap; Herbal formulation; Phytochemical constituents; Medicinal plants; Cosmetic evaluation; Skin care applications.

INTRODUCTION

The skin acts as the primary protective barrier between the human body and the external environment, and products applied to it have a direct influence on skin health and function. Soaps are among the most frequently used personal care products for cleansing; however, many commercially available soaps rely on synthetic surfactants, preservatives, and fragrance compounds. Prolonged use of such formulations has been associated with dryness, irritation, disruption of the skin barrier, and increased sensitivity, highlighting the need for safer and more skin-compatible alternatives.

In recent years, growing awareness of these concerns has increased interest in herbal and naturally derived soaps. Herbal soaps utilize plant-based ingredients that possess established medicinal and dermatological relevance. When multiple herbs are combined in a single formulation, the product is referred to as a polyherbal soap. The concept of polyherbalism, derived from traditional systems of medicine, is based on the principle that combined plant constituents may act synergistically to enhance therapeutic efficacy. In cosmetic applications, this approach allows a single formulation to provide cleansing along with antimicrobial protection, antioxidant support, soothing effects, and improvement in overall skin appearance. Previous studies have reported the effectiveness of polyherbal soaps in improving skin compatibility and functional performance when compared to synthetic soaps.

Guava leaves (*Psidium guajava*), manjistha roots (*Rubia cordifolia*), and cucumber peel (*Cucumis sativus*) are well-documented medicinal plant materials widely used in skincare formulations. Guava leaves are recognized for their antimicrobial and antioxidant properties, manjistha is traditionally valued for detoxifying and complexion-enhancing activity, and cucumber peel is known for its hydrating, cooling, and soothing effects. Although individual herbal soaps have been widely studied, comprehensive reviews focusing on a scientifically justified tri-herbal combination remain limited.

Therefore, the objective of this review is to compile and critically organize existing literature related to polyherbal soap formulations, with specific emphasis on a tri-herbal cosmetic soap containing guava leaves, manjistha roots, and cucumber peel. The review discusses soap chemistry, skin physiology, herbal extraction methods, formulation strategies, and standard evaluation parameters, thereby providing a clear scientific framework for the future development of the proposed TRIHERBA GMC formulation.

SOAP

Soap is produced through a base-catalyzed hydrolysis reaction between an fatty acids and a base, known as saponification reaction.[1] In which oils containing triglycerides react with sodium hydroxide to form soap. The soap molecule consists of a long non-polar hydrocarbon chain that is soluble in non-polar substances and a water-soluble ionic end.[2]

Common soap examples: Sodium stearates, Sodium palmitate, Potassium stearate.
Commercial soap examples: Mysore sandal, Lifebuoy, Lux, Dettol, Dove, Pears, Cinthol, Santoor.

Advantages of Soap: Cleansing action, acts as disinfectant, preserve health, eliminate dirt, removes stains, unpleasant smell in case of clothing, cost effective, biodegradable, mild and suitable for most skin types.[3,4]

Disadvantages of soap: Dehydration of skin, damages skin surface, acidic pH may damage the skin, when compared to detergents soaps have less cleansing power.[4,5]

Applications of Soap: Washing, bathing, prevents spread of diseases, moisturizes the skin.[6]

Classification of Soaps

1. By Physical Form

Solid bar soaps consist of sodium fatty acid salts produced via NaOH saponification of fats/oils, showing TFM of 60-91% and moisture of 4-27% in commercial samples.

Liquid soaps use potassium fatty acid salts from KOH saponification, with TFM of 1-20% and high moisture levels (77-84%).

2. By Key Physico-Chemical Properties

a) pH Categories (Commercial Soaps)

7.0-7.5: Milder for sensitive skin.

8.0-9.5: Standard bathing soaps with effective cleansing.

9.5-10: More alkaline with potential for irritation.

b) Total Fatty Matter (TFM) Grades (Bar Soaps)

Grade I: ≥77% TFM (premium quality, moisturizing for dry skin).

Grade II: 61-76% TFM (standard quality).

Grade III: 51-60% TFM (basic, harder texture).

Liquid soaps typically <20% TFM, evaluated differently.

c) Total Alkali Content (TAC) Safety Levels

<0.5%: Highly safe.

0.5-1.0%: Generally safe.

1.0-1.5%: Possible irritation risk; >1.5% undesirable.

d) By Antimicrobial Strength (against Staphylococcus aureus Zone of Inhibition)

Strong: >20 mm.

Moderate: 15-20 mm.

Weak: 8-15 mm.

Inactive: No zone.

e) Antioxidant Levels (DPPH IC_{50})

Strong: <250 µg/mL.

Moderate: 250-500 µg/mL.

Mild: 500-750 µg/mL.

Very mild: >750 µg/mL.[6]

f) By Herbal Composition

Synthetic soaps: Surfactant-based without herbal actives.

Single-herb soaps: Added one plant extract (e.g., neem, aloe) for antibacterial/skin benefits.

Polyherbal soaps: Multiple extracts combined (e.g. neem + turmeric + garlic; neem + tulsi + soap nut) for enhanced effects like synergy against bacteria or inflammation.[7]

Soaps can be grouped in several ways based on how they are used, what they contain, and how they are made.

g) By usage

Personal or toilet soaps

Non-toilet (general cleaning) soaps

Glycerine rich soaps

Clear or transparent soaps

h) By main ingredients

Soaps containing milk

Soaps made from animal fats

High end or luxury soaps

Perfumed soaps.

i) By manufacturing process

Melt and pour technique

Hot process and cold process methods.

j) Milling (remilling/triple milling) process[8]

Anatomy and Physiology of Skin

Skin is the largest organ in human body and a part of the integumentary system.[9] It serves as protective barrier between the body's internal and external environment and covers approximately 1.5-2 square meters in adults. It plays major roles in protection, temperature regulation, excretion, sensation and immunity.[10]

Structure of Skin

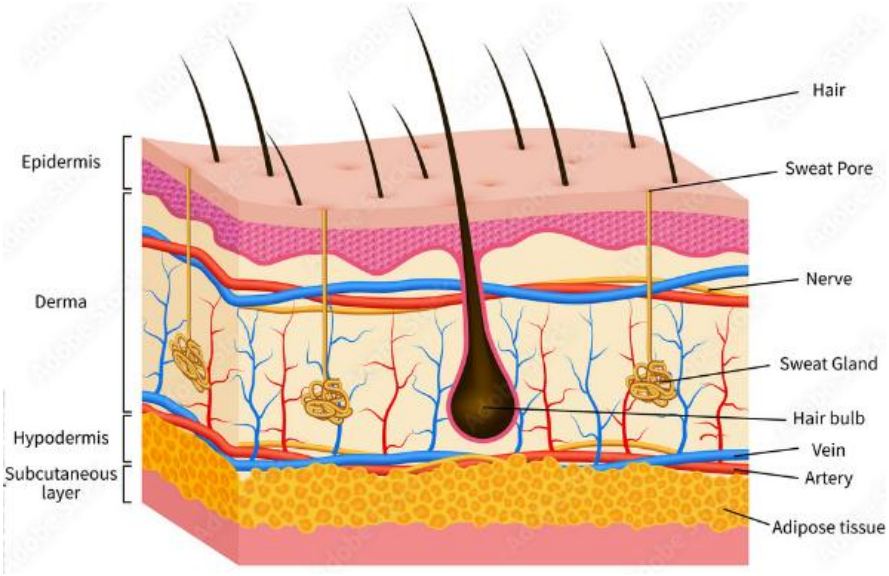


Fig. 1: anatomy of skin.

The skin consists of 3 main layers

Epidermis - The outermost layer of the skin, made up of stratified, keratinized squamous epithelial cells. It receives oxygen and nutrients by diffusion and removes waste products through lymphatic drainage.[10]

Epidermis has following layers

- Stratum corneum: outermost layer, it prevents the internal fluid evaporation (acts as waterproof barrier).
- Stratum lucidum: seen in soles, palms and contains mostly immortalized cells.
- Stratum granulosum: several layers of cells are present which consists of that lipid rich granules.
- Stratum spinosum: desmosomes are present, which makes the cells bound tightly to each other.
- Stratum basalis: deepest, closest layer to dermis.it contains melanocytes, single row of keratinocytes and stem cells.[9]

Dermis: It consists of collagen fibres, elastic fibres formed from connective tissue. These are tough, elastic. Rupture of elastic fibres results in permanent stretch marks and as the age increases tensile strength of the collagen fibres decreases which leads to development of wrinkles on the skin. The dermis primarily contains fibroblasts, macrophages, and mast cells. It also houses blood and lymphatic vessels, sensory nerve endings, sweat glands with their ducts, hair follicles, arrector pili muscles, and sebaceous glands.[10]

Hypodermis: It is the innermost layer containing mainly adipose tissue.[9]

Functions of Skin

Protection: Acts as waterproof barrier and acts against chemicals, microbe's invasion, physical agents (mild trauma, UV light) and dehydration. Langerhans cells are present which are responsible for stimulating the immune response.

Regulation of body temperature: Body temperature is constant at 36.8°C(98.4°F) (variations limited between -0.5° and 0.75°). Heat production can be observed during metabolic activity like contraction of skeletal muscles, when liver is chemically reactive, during peristalsis. Heat loss is achieved by sweating, vasodilation, hypothermia.

Formation of vitamin D: UV light from the sun is converted into vitamin D through 7-dehydrocholesterol (lipid-based substance present in the skin)

Sensation: Stimulation of the nerve endings of sensory receptors which are sensitive to touch, temperature, pressure or pain generates nerve impulses in sensory nerves that are transmitted to the cerebral cortex.

Excretion: excreted out through sweat, urea and removes salt.[10]

Disorders of Skin

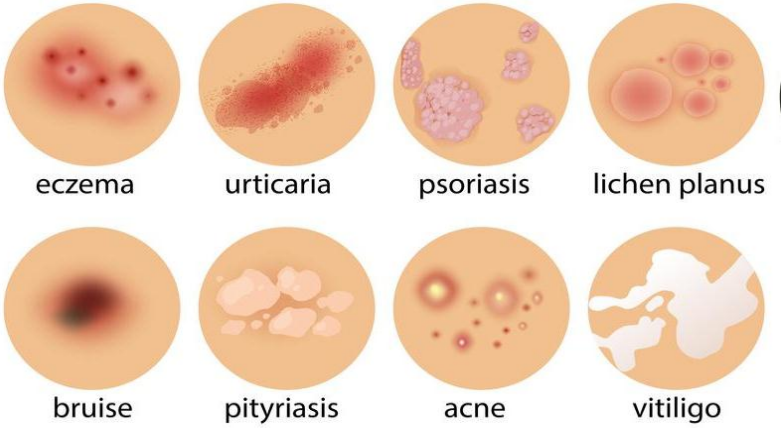


Fig. 2: Disorders of skin.

a) Infections

Viral infections- Human papilloma virus (HPV), herpes virus

Bacterial infections- Impetigo, cellulitis,

Fungal infections- Ringworm and tinea pedis

b) Non-infectious

Eczema and dermatitis: Acute or chronic inflammatory skin conditions characterized by itching and redness, usually triggered by irritants or allergens.

Psoriasis: A condition marked by excessive proliferation of basal epidermal cells, leading to incomplete maturation and the appearance of shiny, scaly skin.

Acne vulgaris: Develops when sebaceous glands and hair follicles become blocked and subsequently infected, resulting in inflammation and pustule formation.

Pressure sores: Also called decubitus ulcers, these lesions form at pressure points where the skin is subjected to prolonged compression between a bony prominence and a hard surface.

Burns: Result from various forms of trauma, including exposure to heat, cold, electricity, or chemicals.

Malignant tumours: Include basal cell carcinoma, malignant melanoma, and Kaposi's sarcoma.[10]

Types of skin

a) **Normal skin-** It is luminous, uniform, even texture without pores, smooth, firm, flexible and hydrated.
b) **Dry skin-** Skin looks clear, dull (sebum deficiency), flaky, appears cold, little flexibility, dehydrated streaks, rough and thin.
c) **Oily skin-** Shiny appearance of the skin, smooth, uneven texture with large pores, thick, pimples, acne scars, hyper-seborrheic.
d) **Sensitive skin-** Scaling, blisters, edemas, redness, dryness, appear hot and rough.
e) **Aging skin-** Wrinkles, pale, dull, uneven texture, enlarged pores, dry, rough, inelastic.[11]

HERBAL SOAP

Herbal soaps are prepared using plant-based materials such as leaves, stems, roots, and fruits and possess antibacterial and antifungal properties, while being free from artificial colours and flavours commonly found in commercial soaps.[12] They are mainly used to treat skin diseases, and injuries while promote good health. Herbal soaps promote skin health, enhance skin radiance, and exhibit antimicrobial activity.[13] It is made up of natural ingredients known for its soothing, healing properties, mostly suitable for sensitive or dry skin and antibacterial, anti-aging, antiseptic properties.[14] Herbs are mainly used to purify the blood as in terms of ayurveda. These are cost effective, easily available, compatible and has high medicinal value.[12]

POLYHERBAL SOAP AND ITS APPROACH IN FORMULATION

Polyherbal soap is combination of herbal extracts and shows it effects in various skin diseases. They are formulated by combining various extracts or powders with soap base.[12] The main advantages of polyherbal soap are natural ingredients are used, hypoallergic, environmentally friendly.[15]

Guava leaf extract- Antibacterial, antimicrobial, antioxidant, wound healing property.[16]
Manjistha root- Acts as detoxifying agent, anti-acne, blood purifier, improves complexion
Cucumber extract- Hydrating, antioxidant, soothing, Minimizes puffiness.[17]

Soap Preparation Methods

Soap is produced by a chemical reaction called as saponification, where fats or oils react with a strong alkali such as sodium hydroxide**.** During this reaction, the fat broken down into

glycerol and fatty acid salts and these salts are known as soap. These long-chain fatty acid salts help lift dirt and oils, making soap an effective cleaner.

a) **Cold Process Method -** Cold- Process soap relies on saponification, a reaction between oils and NaOH. The reaction occurs at low temperatures (30-50) to preserve nutrients in oils. Measure and gently warm the oils. Prepare and cool the NaOH solution. Mix oils and lye at 30 -50 C. Stir until trace appears(thickening). Pour the mixture into moulds.

b) **Hot Process Method -** The principle of this method uses saponification accelerated by heat, where oil react with NaOH at 50-100 C to form soap and glycerol. Heating drives the reaction to completion quickly, allowing the soap to be usable immediately after cooling.

Procedure- Measure oils/butters and melt them in a slow cooker. Prepare the NaOH solution and add it to the melted oils. Heat the mixture at 50-100C, stirring until it thickens and reaches gel phase. Continue cooking until saponification completes (about 30 minutes)**.** Transfer the hot soap mixture into moulds and allow it to undisturbed for 12-24 hours**.** Unmould, cut into bars, and cure for 1-2 weeks to improve quality.

c) **Melt and Pour Method** is method works by melting a pre- saponified soap base and adding additives before it solidifies again in moulds. Cut the pre- made soap base into small chunks**.** Melt the base and add the fragrance, colour and any desired additives. Stir gently to combine. Pour the mixture into moulds to set.

d) **Re-Batching Method -** It involves melting existing soap to react it, allowing ingredient adjustment before moulding. Grate or chop the existing soap. Melt it with a small amount of liquid using gentle heat (crock pot or double boiler). Add ingredients or make the adjustments. Pour the melted soap into moulds to set.

e) **Liquid soap Method -** Principle involved in Liquid soap is made through saponification using KOH and various oils and butters, to form a soap paste that is later diluted into liquid. Oils and butters are combined with a KOH solution. The oils and lye solution are thoroughly blended. The mixture is heated in a slow cooker. Continuous or intermittent mixing is carried out depending on the temperature. The mixture is allowed to saponify until it forms a thick paste. The diluted soap is kept thin for former bottles or thickened with salt or other agents for a gel consistency in pump bottles.[18]

General Methods for Extraction of Herbal constituents

a) **Soxhlet extraction**: This method is used for the compounds which have less or limited solubility. If the compound is highly soluble then simple filtration is used. One batch of

solvent can be used multiple times in this procedure. It is not suitable for thermolabile substances.

b) **Maceration**: Coarsely fine powdered extract of the compound is added into the suitable solvent in an air tight container for some time with occasional shaking until the soluble matter gets dissolved. Thermolabile drugs can be extracted by this method.

c) **Decoction**: Water soluble, heat stable constituents are extracted through this process by boiling them 15minutes in water, cooling, straining.

d) **Infusion**: Readily soluble crude drugs are diluted in order to achieve the components. They are freshly prepared by dissolving them in hot or cold water for some time.

e) **Digestion:** This procedure is similar to maceration where gentle heat is applied.

f) **Percolation**: Extraction of active ingredients is seen by this method where percolator is used. Finely powered drug in dissolved in suitable menstruum let it stand for some time in an air tight container for 24hours. Then open the outlet and allow the liquid to flow out drop by drop slowly. Further menstruum is added to make up to the required volume.

g) **Sonication**: In this method ultrasound frequency ranges from 20 kHz to 2000 kHz; permeability of cell walls increases and cavitation is produced. it is limited due to the higher costs. One disadvantage of the procedure is formation of free radicals and consequently undesirable changes in the drug molecules.[19]

h) **Supercritical fluid extraction (SFE)**: Mainly gases are used, they are compressed in dense liquid and pumped into a cylinder which consists of the materials which are to be extracted and then it is pumped into the separating chamber and extract is collected, gas is separated and can be reused. Main advantage of this method is that solvent residues are not traced as complete evaporation of co2 takes place.

i) **Microwave-assisted extraction (MAE)**: Extraction takes place by heating solvent, plant tissue with the help of microwave. Where rupture of cell wall takes place due to the pressure and exudation of active constituents takes place.[20]

Monograph of *Psidium guajava* (Guava)



Fig 3: guava leaves.

Taxonomical Classification

Table 1: Taxonomical classification of guava.[21]

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Myrtales
Family	Myrtaceae
Subfamily	Myrtoideae
Genus	Psidium
Species	guajava

Description: The leaves are oblong elliptical to oval, measuring 3 to 6 inches in length, with an acute to rounded tip. The underside of the leaves is finely hairy, while the upper surface is notable for its clearly visible, impressed veins.[22]

Chemical Constituents: Phenolic (gallic acid, ellagic acid), Flavonoid (quercetin, rutin), Ellagitannins (corilagin), Tannin (pedunculagin), Terpenoid (B-caryophyllene, sesquiterpenes, oleanolic acid) and glycosides, alkaloids, lignans, plantsteroids (B-sitosterol), curcumin, saponins, guavinoside (A, B, C, F), proteins (lectins).[21,23]

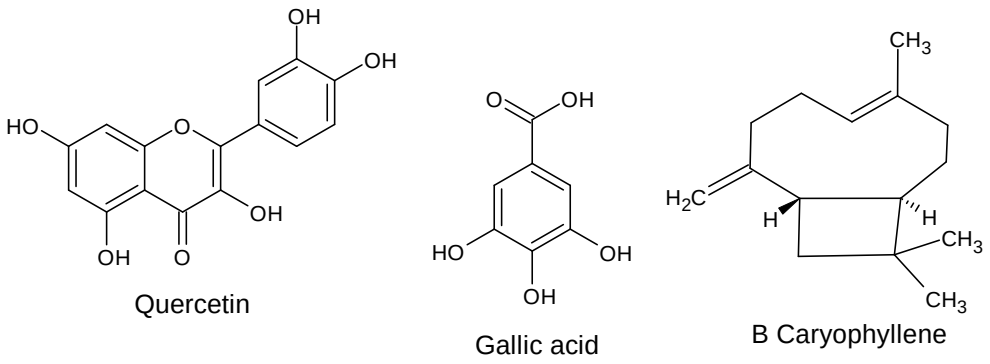


Fig. 4: Structures of some primary chemical constituents of guava leaves.

Pharmacological activities: Anti-oxidant, anti-microbial, anti-diarrheal, anti-diabetic, anti-tumour, healing and cytotoxic, hepatoprotective, anti-malarial, anti-inflammatory, dental plaque, anti-glycation.[21]

Uses in Skin: Phenolic compounds show antioxidant property which enhances solubility, skin penetration and boosting their anti-aging and helps in skin protection. The topical application of antioxidants prevents skin aging, skin cancer and skin damage by oxidative

stress.[24] Oleanolic acid contains antioxidant and anti-inflammatory properties which has potential benefits for skin health. Quercetin supports anti allergic properties. Flavonoids known for their antioxidant property which helps to reduce oxidative stress from the body. Tannins has anti-microbial and antioxidant property that cause astringency. Ellagic acid with antioxidant property supports skin health.[23] The leaves are used for wounds, skin ulcers, cuts and improves skin tonicity.[21]

Mechanism of Action

Anti-inflammatory: B-caryophyllene (BCP) shows anti-inflammatory activity by suppressing inducible nitric oxide (iNOS), thereby reducing nitric oxide (NO), reactive nitric oxide species (RNOS), and reactive oxygen species (ROS). This decreases cGMP-mediated signaling, limiting oxidative stress and inflammatory responses, including vascular, immune, and neutral pathways in skin and other tissues.

Anti-bacterial: Quercetin shows antibacterial properties by disrupting the bacterial cell wall and modifying membrane permeability. It interferes with protein synthesis and enzyme function, and nucleic acid Formation. Its antibacterial potency can be modulated by sulfation or phosphorylation at hydroxyl groups, affecting solubility and activity against specific bacterial species, and it can act synergistically with antibiotics.[23]

Anti-oxidant: Guavinoside (A, B, C, F) along with quercetin are the phytochemical compounds known for their antioxidant properties. These compounds help delay or supress the oxidation of lipids and other molecules by interfering with the initiation or propagation of oxidative chain reactions. They protect cells from damage caused by reactive oxygen species (ROS) or oxygen derived reactive species through mechanism such as reducing activity, free radical scavenging, metal ion chelation, and singlet oxygen quenching.[21]

Monograph of *Rubia cordifolia* (Manjishtha)



Fig. 5: manjistha roots.

Taxonomical Classification

Table 2: Taxonomical classification of manjistha.[25,26,27]

Taxonomic rank	Classification
Kingdom	Plantae
Class	Dicotyledons
Subclass	Sympetalae
Order	Rubiales
Family	Rubiaceae
Genus	Rubia
Species	cordifolia

Description: Manjishtha is a perennial, herbaceous climber with roots which are long, cylindrical, twisted and are covered by a thin red bark which contains flexuose.[25,27]

Major Phytochemical Constituents: Rubia cordifolia consists of a variety of phytochemical constituents such as anthraquinone and their glycosides being the major components. These include Purpurin, manjistin, rubiadin, mollugin, 7-hydroxy-2-methylanthraquinone, 1,3dihydroxyanthraqunone, alizarin, lucidin, ruberythric acid, 1-methoxymethylanthraquinone, and lucidin-3-O-primeveroside, 2-methyl-1,3,6trihydroxy-9,10- anthraquinone, and their various glycosidic derivatives. In addition, naphthoquinones and their glycosides, terpenes such as rupirasins A, B, C, D, E and F, bicyclic hexapeptides (RA-V & RA-VII) and other constituents include iridoids, flavonoids and carbohydrates are also present. Cordifoliol and cordifodiol are two novel anthraquinones. The phenolic contents mainly include hydroxyanthraquinones, gallic acid, and tannins.[25]

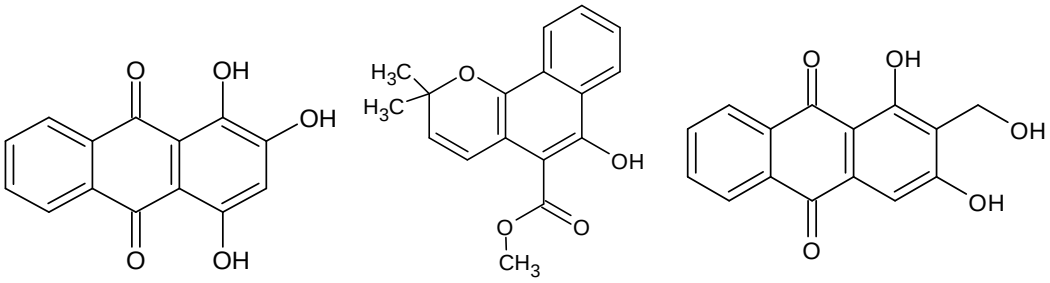


Fig. 6: Structures of some primary chemical constituents of manjistha roots.

Pharmacological Activities – Rubia cordifolia exhibits a wide range of pharmacological activities, including anti-inflammatory, Anti-allergic, anti-proliferating, anti-ulcer, anti-urolithiasis, anti-platelet, anti-viral, anti- bacterial, anti-arthritic, nephroprotective, neuroprotective, radioprotective, gastroprotective, anti-adipogenic, anti- HIV, anti-tumour,

wound healing, anti- oxidant, cardioprotective, anti-diabetic, hepatoprotective, anti-cancer, nephrotoxicity, anti-acne, anti-convulsant, anti-peroxidative, anti-stress, nootropic activity, immunomodulators.[25,28,29]

Uses in skin- Presence of Anthraquinones in R. cordifolia exhibits the anti-acne property. Ethanolic extracts of R. cordifolia roots possess significant wound healing activity. [29] Dried powdered roots are used in treatment of skin diseases. R. cordifolia, C. asiatica, T. belerica, P. zeylanica and W. somnifera formulate wound healing property which leads to wound compression. The anti-inflammatory effect of R. cordifolia causes oedema.[28] Manjistha root used as blood purifier. Eladyarishtam is a liquid extract of manjistha roots which is used for skin diseases and allergic skin disorders.[25] Manjistha oil is used to inhibit acne causing bacteria and is considered for effective for skin brightening.[27]

Mechanism of Action

Anti-inflammatory activity: The anti-inflammatory activity of manjishtha is attributed to the presence of rubimallin. This compound inhibits the lipoxygenase enzyme pathway and promotes the synthesis of inflammatory compounds like leukotrienes, that play a role in inflammatory conditions.[29]

Wound healing: root extract of R.cordifolia shows wound healing effect by increasing wound contraction, accelerating epithelization, and facilitating new epithelial tissue formation.[30]

Antiproliferative Property: mollugin has antiproliferative effect[29], the aqueous extract of R. cordifolia root inhibits the [3H]-thymidine incorporation in A-431 epidermal carcinoma cells as well as 3T3 fibroblast cells indicating inhibition of cell proliferation.[30]

Anti-microbial activity: The extracts of Rubia cordifolia demonstrate inhibitory activity against Propionibacterium acnes in normalized cultures. The root extract, when used to synthesize green silver nanoparticles, it exhibits strong antibacterial activity against microorganisms including, Vibrio alginolyticus, Plesiomonas shigelloides, pseudomonas aeruginosa, shigella spp., and vibrio parahaemolyticus. The highest antibacterial effect observed against pseudomonas aeruginosa and plesiomonas shigelloides.[30]

Monograph of *Cucumis sativus* (Cucumber)



Fig. 7: cucumber peels.

Taxonomical Classification

Table 3: Taxonomical classification of cucumber.[31]

Taxonomic rank	Classification
Kingdom	Plantae
Division	Angiosperms
Class	Eudicots
Order	Cucurbitales
Family	Cucurbitaceae
Genus	Cucumis
Species	sativus

Description: Cucumis sativus, commonly called as cucumber, these are "cylindrical, elongated with tapered ends, smooth and shiny body consists of lumps or ridges", cultivated in temperate zone (temperature above 20°C). It is susceptible and thermophilic in nature.[32]

Major phytochemical constituents: Cucumber contains many important natural chemicals that give it both nutritional and medicinal value. Along with about 95% water, it has vitamins A, C, E and K and B-complex, and minerals like potassium, magnesium, calcium, iron, zinc, copper, manganese and selenium, plus a little protein, carbohydrates and fat. Its main plant chemicals include phenols and polyphenols, flavonoids (quercetin, kaempferol, apigenin, luteolin, vitexin, isovitexin, orientin, isoorientin,), tannins, terpenoids and triterpenoids (especially cucurbitacins A-E), steroids and phytosterols (beta-sitosterol, campesterol, stigmasterol), saponins, glycosides, lignans, carotenoids and phenolic acids like caffeic and ferulic acid. Even the peel and seeds are rich in tannins, flavonoids, saponins, alkaloids, reducing sugars and chlorophyll, so almost every part of cucumber shows strong antioxidant and bioactive potential.[32,33]

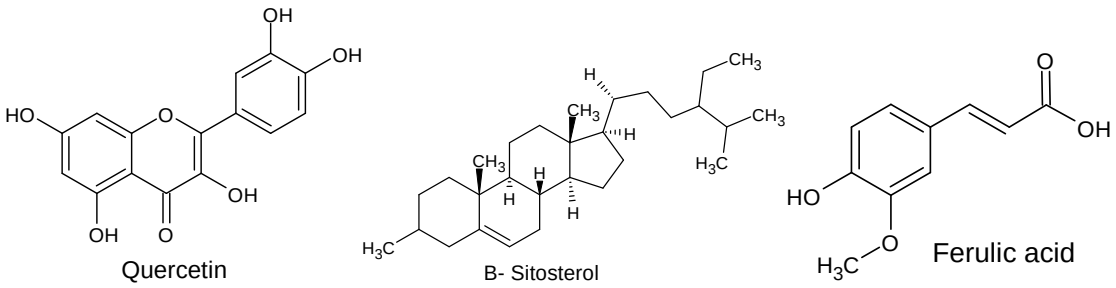


Fig. 8: Structures of some primary chemical constituents of cucumber peels.

Pharmacological activities: Because of this phytochemical mix, cucumber shows a wide range of pharmacological activities. Studies and traditional use describe antioxidant, anti-inflammatory, anti-diabetic, hypolipidemic (cholesterol-lowering), cardioprotective, laxative, anti-ulcer, hepatoprotective, antibacterial, antifungal, cytotoxic and wound-healing actions. It has been used to help in conditions such as hypertension, diabetes, hypercholesterolemia, kidney stones, constipation, atherosclerosis and some cancers, as well as for general detoxification and protection against oxidative stress. The cucurbitacins contribute mainly to anticancer and anti-inflammatory effects, flavonoids and phenolic acids provide strong free-radical scavenging, while phytosterols and lignans support heart health and hormone-related cancer protection.[32,33]

Uses in skin: In skin care, cucumber is a very popular ingredient because its chemical constituents directly support skin health and appearance. Vitamin C, vitamin E, carotenoids and flavonoids act as antioxidants to protect skin from damage and early ageing, while vitamin K helps reduce puffiness and dark circles around the eyes. Natural alpha-hydroxy acids (glycolic and lactic acid) and beta-hydroxy acid (salicylic acid) in cucumber gently exfoliate, remove dead cells, improve collagen and elasticity, and help in conditions like dull skin, fine wrinkles, spots and mild acne. Extracts and juice are used in soaps, creams, lotions, face packs, toners and eye pads to cool and hydrate the skin, soothe sunburn and irritation, lighten and even out skin tone, reduce swelling and inflammation, and promote smoother, softer and brighter skin, which makes cucumber highly suitable for polyherbal cosmetic and soap formulations.[31,32,33]

Mechanism of Action

Anti-bacterial: Cucumber extracts containing sphigo lipids, flavonoids, tannins and saponins exhibit antimicrobial activity against several bacteria and fungi, indicating potential to reduce microbial presence on skin.

Anti-fungal activity: Cucumber contains rhamnetin, sphingolipids, tannins, quercetin, glycosides, saponins and alkaloids which exhibit antifungal activity. Cucumber ethanolic extracts act against multiple fungal strains, decreasing fungal presence on the skin.

Soothing effect: Alpha hydroxyl acids such as glycolic and lactic acids dissolve the glue-like substance in the epidermis. This action facilitates the exfoliation of dead skin cells, enhances skin texture and maintaining the integrity of the outer protective layer, resulting in healthier smoother skin.[32]

Extraction of Herbal Constituents

Extraction of Guava leaf - Guava leaf extraction can be performed by macerating shade-dried, powdered leaves in either 70% methanol[34] or 50% ethanol[35] at room temperature for 48-72 h with occasional shaking. Filtration of mixture followed by concentrating at 40-50°C yields a viscous extract containing quercetin, flavonoids, and phenolics. This hydroalcoholic method optimally recovers polar antimicrobials and antioxidants for herbal soap formulations.

Extraction of Manjistha root - Manjistha root extraction can be performed by macerating air-dried, powdered roots 50%[36] or 70%[37] ethanol at room temperature for 48-72 h. Filtration of mixture followed by concentrating by rotary evaporation at 50-60°C, yielding a reddish-brown viscous residue rich in anthraquinones like purpurin and alizarin for skin-brightening effects. This hydroalcoholic approach effectively recovers polar bioactives suitable for herbal soap incorporation.

Extraction of Cucumber peel - Cucumber peel extraction can be typically performed by macerating dried, powdered cucumber peel in 80% methanol[38] at room temperature for 48-72 hours with occasional stirring. Filtration of mixture followed by concentrating under reduced pressure using a rotary evaporator at 40-50°C to yield a greenish viscous residue. This hydroalcoholic extraction method efficiently recovers flavonoids, cucurbitacins, and ascorbic acid, which are important bioactive compounds providing moisturizing and soothing properties in herbal formulations.

Formulation of Polyherbal Soap

The polyherbal soap can be formulated using a cold-process method in which a fixed proportion of oils is saponified with sodium hydroxide, and concentrated herbal extracts can

be incorporated during trace. The oil phase consists of coconut oil, sunflower oil, castor oil and cocoa butter, which together form a saponifiable base. A pre-calculated quantity of NaOH dissolved in distilled water acts as the alkali solution. Concentrated extracts of guava leaves, manjistha root and cucumber peel are blended and added to the soap mixture at medium trace to ensure uniform dispersion. The mixture is poured into moulds, insulated for 24-48 hours and allowed to cure for 4–6 weeks to ensure complete saponification and optimal hardness.[39,40,41]

Evaluation of Polyherbal Soap

a) Organoleptic assessment - The prepared soap bars are visually evaluated for colour, surface uniformity, cracks, and texture, and are assessed for odour and hardness by simple manual inspection and thumb pressure.[39]

b) pH - It is determined by dispersing a known quantity of soap (usually 1% w/v) in distilled water, allowing it to equilibrate, and measuring with a properly calibrated digital pH meter at room temperature.[1,39]

c) Foam properties

- **Foam height -** A 1% w/v soap solution is transferred to a graduated cylinder, shaken for a fixed number of strokes, and the foam height is measured immediately after shaking.[39]
- **Foaming index -** Serial dilutions of soap solution are shaken in calibrated tubes; the lowest concentration producing a standard foam height of 1 cm after a fixed time is used to calculate the foaming index.[42]
- **Foam retention time -** Foam height of the soap solution is recorded at predetermined time intervals after shaking; the time taken for foam to reduce to 50% is foam retention time.[3]

d) Moisture content - Accurately weighed soap samples are dried in a hot air oven at 105°C to constant weight, and moisture content is calculated by loss on drying.[1,39]

e) Anti-microbial assay - Cup plate method

Standardised bacterial suspensions are inoculated into molten agar, poured into plates, and wells are cut in the solidified agar. Fixed volumes of soap solution are added to the wells, plates are incubated, and antimicrobial activity is evaluated by measuring zones of inhibition.[1,43]

c) Free alkali content - Soap is dissolved in distilled water and titrated with standard acid using phenolphthalein as indicator, and free alkali is calculated from the titration volume.[1,39]

d) **Total Fatty Matter (TFM) -** Ten grams of soap are dissolved in hot water and acidified with 15% H_2SO_4 to release fatty acids. After heating to obtain a clear solution, beeswax is added to solidify the separated fatty acids. The solid cake is removed, dried, and weighed. TFM is calculated from the weight difference between the cake and wax relative to the soap sample.[3]

e) **Phytochemical Analysis -** Qualitative phytochemical screening of the soap extract is carried out using standard colour and precipitation tests for major secondary metabolites such as alkaloids, flavonoids, tannins, saponins, glycosides, phenols, Steroids and terpenoids.[39]

f) **Skin irritation test** - The test is performed by applying the soap sample to the skin for a duration of 10 minutes. Absence of visible irritation indicates that the product is non-irritating.[44]

CONCLUSION

This review highlights the strong potential of polyherbal soaps as natural and skin-friendly alternatives to conventional chemical soaps. By combining guava leaves, manjistha roots, and cucumber peel, a tri-herbal soap formulation can provide effective cleansing along with antibacterial, antioxidant, soothing, and skin-enhancing benefits. The literature clearly shows that each of these herbs contributes unique and valuable properties that support skin health, and their combined use may offer improved results compared to single-herb formulations.

The review also emphasizes the importance of proper extraction methods, suitable formulation techniques, and standard evaluation parameters to ensure the quality, safety, and effectiveness of herbal soaps. Tests such as pH, foam characteristics, total fatty matter, antimicrobial activity, and skin irritation assessment play a key role in confirming that the product is gentle and suitable for regular use.

Overall, this work brings together scattered information into a clear and structured form, making it useful for students, researchers, and formulators. It provides a strong scientific foundation for the future development of an experimental tri-herbal soap formulation such as TRIHERBA GMC. With further research and formulation studies, such polyherbal soaps have the potential to become safe, effective, and affordable skincare products that meet the growing demand for natural personal care solutions.

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