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Review on Sea Buckthorn Berries in Poly herbal Lipstick Formulation

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Abstract: *Sea buckthorn (Hippophae rhamnoides) is a nutrient-dense berry valued for its bioactive constituents, including carotenoids, flavonoids, vitamins, and essential fatty acids. These compounds exhibit antioxidant, anti-inflammatory, photoprotective, and wound-healing activities, making sea buckthorn a promising ingredient for cosmetic and therapeutic applications, particularly in poly herbal lipstick formulations 1,2.*

Incorporating sea buckthorn oil or extracts into lipsticks not only provides natural coloration but also enhances moisturization, barrier protection, and overall lip health, offering a combined cosmetic and functional advantage. Polyherbal formulations often combine sea buckthorn with other natural pigments, such as beetroot (betalains), along with emollients like shea butter and cocoa butter, improving texture, spreadability, and consumer appeal 3,4.

Formulation challenges such as color fading, lipid oxidation, strong odor, and standardization of bioactive content can be addressed through antioxidants, encapsulation methods, and controlled processing techniques. Regulatory guidelines, including the EU Cosmetic Regulation (EC No. 1223/2009) and FDA Cosmetic Ingredient Review, classify sea buckthorn as safe for cosmetic use, provided proper microbial, heavy metal, and preservative standards are followed 5,6.

Future directions involve advanced extraction techniques, nanoencapsulation, clinical validation, and development of multifunctional cosmeceutical lipsticks, ensuring enhanced stability, bioavailability, and consumer acceptability. This review provides a comprehensive overview of the Pharmacognosy, phytochemistry, formulation strategies, functional benefits, and regulatory aspects of sea buckthorn in poly herbal lipstick, highlighting its potential in natural cosmetic development.

Keywords: Sea Buckthorn, Carotenoids, Flavonoids, Omega-7 Fatty Acids, Herbal Cosmetics, Antioxidant Activity, Lip Care, Natural Colorants, Emollients

I. INTRODUCTION

Lipsticks are more than just cosmetic products—they not only enhance beauty but also provide protection and nourishment to lips, which are prone to dryness, cracking, and environmental damage. With the rising demand for natural and herbal cosmetics, there has been growing interest in incorporating bioactive plant ingredients that provide both cosmetic appeal and therapeutic benefits[7,8] .

Sea buckthorn (*Hippophae rhamnoides* .), a bright orange-yellow berry, has emerged as a promising herbal ingredient for lip care products. Rich in carotenoids, flavonoids, vitamins (A, C, E, K), and essential fatty acids, sea buckthorn not only adds a natural hue to lipsticks but also offers antioxidant, anti-inflammatory, photoprotective, and wound-healing properties [1,9]. These multifunctional characteristics make it ideal for polyherbal lipstick formulations, where it can work synergistically with other natural pigments like beetroot (betalains), and emollients such as shea butter, cocoa butter, and castor oil.

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Formulating a herbal lipstick with sea buckthorn involves careful consideration of stability, color retention, texture, and sensory appeal. The berry's bioactive compounds are sensitive to light, heat, and oxidation, which may affect both color and functional efficacy. Advanced formulation strategies such as nanoencapsulation, antioxidant incorporation, and optimized wax-oil balance help overcome these challenges[10,11].

Beyond aesthetics, sea buckthorn-enriched lipsticks provide functional benefits, including moisturizing the lips, preventing oxidative damage, and promoting healing of chapped or cracked lips. Moreover, natural ingredients like sea buckthorn align with consumer demand for safe, chemical-free, and sustainable cosmetic products, which are increasingly preferred in the global market[4,12].

This review highlights the pharmacognosy, phytochemistry, formulation aspects, functional and cosmetic benefits, safety, and regulatory considerations of sea buckthorn in polyherbal lipstick. It aims to provide a comprehensive understanding of its potential as a natural ingredient that bridges beauty and therapeutic care in modern herbal cosmetics.

Pharmacognosy of Sea Buckthorn Berry (Hippophae rhamnoides) :

1. Biological Source

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Rosales
Family: Elaeagnaceae
Genus: Hippophae
Species: Hippophae rhamnoides L.
Common Names: Sea buckthorn, Indian seaberry, Sandthorn
Part Used: Fruit (berry) – primary source; seeds, leaves, and pulp are also used in herbal formulations[1,2]

2. Botanical Description

Deciduous, thorny shrub, 2–4 m tall.
Narrow, lanceolate, silver-green leaves.
Bears bright orange-yellow to reddish-orange berries on branches, 5–8 mm in diameter.
Grows in sandy, well-drained soils, tolerant to extreme cold and drought[2,13] .

3. Macroscopic Characteristics of Berry

Shape: Round to oval
Surface: Smooth, shiny, with soft pulp

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Color: Orange-yellow to reddish-orange
Taste: Sour, slightly astringent
Odor: Fruity characteristic [14]

4. Microscopic Characteristics

Epidermis: Single-layered with cuticle.
Mesocarp: Parenchymatous cells containing oil droplets and carotenoid pigments.
Seeds: Protein-rich endosperm with lipid droplets[15]

5. Physicochemical Properties

Moisture content: ~70–80% in fresh berries
pH: 2.5–3.5 (acidic)
Total carotenoids: 0.3–0.6% in fresh fruit
Oil content: 5–10% in pulp, 8–12% in seeds[16,17]

6. Chemical Constituents

Vitamins: A, C, E, K
Carotenoids: β-carotene, lycopene, zeaxanthin
Fatty acids: Palmitoleic acid (omega-7), linoleic acid, oleic acid
Flavonoids & Phenolics: Quercetin, isorhamnetin, kaempferol
Triterpenes: Present in pulp and seed coat [17,18]

Phytochemical Profile of Sea Buckthorn Berry :

Sea buckthorn (*Hippophae rhamnoides L*) berries are often called a "superfruit" because they are packed with many natural compounds that are useful for both health and cosmetics. These natural chemicals not only protect the skin and lips but also make sea buckthorn a promising ingredient for polyherbal lipstick formulations.

1. Natural Pigments (Carotenoids)

2. The berries are naturally rich in β-carotene, lycopene, lutein, and zeaxanthin, which give them their bright orange-red color.

These compounds act as powerful antioxidants, protect lips from UV light, and provide a natural tint in herbal lipsticks[19].

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2. Vitamins

Sea buckthorn berries are one of the richest natural sources of vitamin C, even higher than oranges. This supports collagen formation and keeps lips healthy.

They also contain vitamin E (tocopherols and tocotrienols), which prevent dryness and protect lipids from oxidative damage.

Small amounts of vitamin K and B-group vitamins help with skin repair and nourishment [20].

3. Healthy Oils (Fatty Acids)

Sea buckthorn oil is unique because it has omega-3, omega-6, omega-7, and omega-9 fatty acids.

Omega-7 (palmitoleic acid) is very rare in plants and plays a big role in healing cracked lips and improving moisture [21].

4. Flavonoids and Polyphenols

These are natural compounds like quercetin, kaempferol, and isorhamnetin.They help fight inflammation, protect against infections, and slow down aging of delicate lip skin [22].

5. Plant Sterols and Organic Compounds

Compounds like β-sitosterol and campesterol support healing and anti-inflammatory actions.

The berries also contain organic acids (such as malic and quinic acid) that help maintain the natural pH balance, useful for stable lipstick formulations [23].

6. Minerals

Sea buckthorn also provides minerals like potassium, magnesium, calcium, and iron, which contribute indirectly to healthy skin and tissue metabolism [24].

Cosmetic and Functional Benefits of Sea Buckthorn Berry in Poly herbal Lipstick:

Sea buckthorn (*Hippophae rhamnoides*) berry is highly valued in cosmetic formulations due to its rich profile of carotenoids, flavonoids, vitamins, and essential fatty acids. When incorporated into poly herbal lipstick, it provides both cosmetic appeal (color, texture, sensory properties) and functional benefits (therapeutic and protective actions on lips).

1. Natural Coloring Agent

Sea buckthorn is a potent source of carotenoids (β-carotene, lycopene, zeaxanthin), imparting a natural orange-red hue to formulations [9].

Its pigment-rich fractions can replace synthetic dyes, making the product safer and more consumer-friendly [11].

2. Moisturization and Barrier Protection

The oil fraction is rich in palmitoleic acid (omega-7), linoleic acid (omega-6), and oleic acid (omega-9), which restore lipid layers and prevent transepidermal water loss [25].

These fatty acids improve softness and smoothness of lips, acting as natural emollients [7].

3. Antioxidant & Anti-aging Action

Carotenoids, tocopherols, and vitamin C scavenge free radicals and prevent oxidative stress-induced lip aging [26].

Continuous application helps in reducing dryness, cracking, and fine lines of lips [27].

4. Photoprotection (UV Defense)

Sea buckthorn extracts contain flavonoids and carotenoids which absorb UV radiation, protecting lips from photodamage and pigmentation [28].

Combined with other herbal actives, it enhances natural sun protection in lip care products [29].

5. Wound Healing & Regeneration

Clinical studies show sea buckthorn promotes epithelial regeneration and collagen synthesis, aiding in the healing of cracked or chapped lips [30].

Its omega-7 fatty acid supports mucosal and skin repair [31].

6. Anti-inflammatory Effect

Flavonoids and triterpenoids reduce lip irritation, redness, and burning sensation caused by environmental factors [32].

It can soothe inflamed lips and prevent recurrent chapping [33].

7. Antimicrobial Action

Sea buckthorn extracts inhibit bacterial and fungal growth on the lips due to bioactive flavonoids and phenolic acids [34].

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This ensures hygiene and reduces the risk of lip infections [35].

8. Functional Synergy in Polyherbal Formulation

In combination with beetroot (betalains), shea butter, cocoa butter, and beeswax, sea buckthorn will provide dual benefits:

Cosmetic: Color enhancement, smooth application, glossy finish.

Functional: Long-lasting moisturization, protection against oxidative and microbial damage[4].

Role of Sea Buckthorn Berry in Lipstick Base:

In polyherbal lipstick formulations, the base usually comprises waxes, butters, and oils that provide structure, spreadability, gloss, and protective functions. The incorporation of sea buckthorn berry (fruit oil, seed oil, or carotenoid-rich extract) offers additional cosmetic and therapeutic properties that enhance both the performance and consumer appeal of the lipstick.

1. Emollient and Conditioning Agent

Sea buckthorn oil contains high levels of palmitoleic acid (omega-7), oleic acid, and linoleic acid, which act as natural emollients.

These fatty acids soften the wax base, improve glide during application, and provide long-lasting moisturization [37,7].

2. Color and Aesthetic Appeal

Carotenoids such as β-carotene, lycopene, zeaxanthin impart a natural yellow to orange-red hue.When blended with other herbal pigments like beetroot betalains, sea buckthorn enhances the overall shade variety and intensity without relying on synthetic dyes [37,3].

3. Stability Enhancer

The oil fraction is rich in tocopherols (Vitamin E) and ascorbic acid derivatives, which act as natural antioxidants.

These compounds not only protect the oil itself from rancidity but also stabilize the entire lipstick matrix, extending shelf life [38].

4. Healing and Protective Base Component

Unlike neutral oils (e.g., mineral oil), sea buckthorn oil provides functional benefits such as wound healing, anti-inflammatory activity, and barrier repair.

This makes the lipstick not just decorative but also therapeutic for chapped or damaged lips[1,39] .

5. Improved Spreadability and Texture

Sea buckthorn oil reduces the brittleness of wax-heavy bases and improves lipstick glide and smoothness during application.

Its semi-drying nature contributes to a glossy yet non-greasy finish [40].

6. Synergy in Polyherbal Systems

In a polyherbal lipstick, sea buckthorn oil works synergistically with cocoa butter, shea butter, and beeswax by:

Softening the wax matrix,

Enhancing bioactivity (antioxidant + antimicrobial),

Providing a balanced structure between firmness and smoothness [4]

Pharmacological Benefits of Sea Buckthorn Berry for Lips :

Sea buckthorn (Hippophae rhamnoides .) has been extensively investigated for its dermatological and mucocutaneous benefits owing to its unique composition of carotenoids, polyunsaturated fatty acids, vitamins, and flavonoids. These constituents provide multiple pharmacological effects that are directly relevant to lip health and cosmetic enhancement.

1. Wound Healing and Regeneration

Sea buckthorn oil contains palmitoleic acid (omega-7), which is a natural component of skin lipids. It promotes epithelial regeneration and accelerates healing of cracks and fissures in the lips [41].

2. Moisturization and Barrier Repair

The high content of omega-3, omega-6, and omega-9 fatty acids strengthens the lipid barrier of lip skin, preventing dryness and improving hydration [42].

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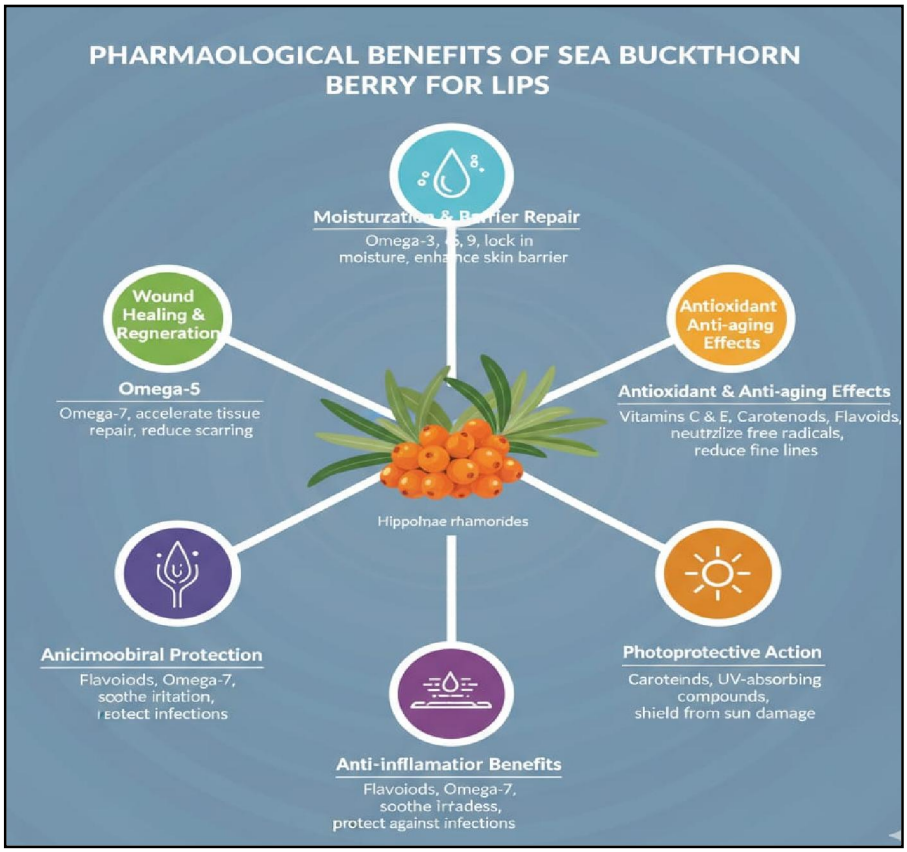
3. Antioxidant and Anti-aging Effects

Carotenoids (β-carotene, lycopene), tocopherols (vitamin E), and ascorbic acid (vitamin C) act as potent antioxidants. These compounds neutralize reactive oxygen species (ROS), thereby reducing oxidative stress that contributes to premature lip aging and dullness [43].

4. Photoprotective Action

Carotenoids and flavonoids in sea buckthorn absorb UV radiation and reduce photo-induced damage. This property makes it suitable for use in lipsticks with SPF benefits [44].

5. Anti-inflammatory Benefits



Flavonoids and fatty acids present in the berry oil exert anti-inflammatory activity, reducing irritation, redness, and sensitivity of lip skin [45].

6. Antimicrobial Protection

Sea buckthorn extracts have demonstrated inhibitory activity against various microorganisms. This property may enhance the safety and preservation of herbal lipsticks while protecting lips from microbial colonization [24].

Extraction & Processing of Sea Buckthorn Berry for Lipstick Formulation:

The method of extraction and subsequent processing of sea buckthorn (Hippophae rhamnoides) plays a decisive role in the stability, color intensity, and bioactive profile of polyherbal lipstick formulations. Various techniques have been explored for obtaining both oils and pigment-rich extracts suitable for cosmetic use.

1. Cold-Press Extraction

Principle: Mechanical pressing of seeds or pulp at low temperature.

Benefits: Retains heat-sensitive vitamins, carotenoids, and fatty acids; solvent-free, eco-friendly, and consumer-preferred for "natural" cosmetics.

Limitations: Lower yield compared to advanced methods; requires filtration to remove particulate matter.

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Use in lipstick: Provides emolliency and natural yellow-orange tint, but may require antioxidant addition to prevent oxidation[46,2].

2. Solvent Extraction

Principle: Food-grade solvents such as ethanol or hexane are used to extract oils or phenolic-rich fractions.

Benefits: High yield; flexibility in targeting different phytoconstituents depending on solvent polarity.

Limitations: Residual solvent risk, regulatory restrictions, and potential thermal degradation of carotenoids.

Use in lipstick: Extracts are suitable after refining and solvent-removal; ethanol extracts can provide phenolic antioxidants to enhance product stability[47,7].

3. Supercritical CO_2 Extraction (SFE)

Principle: Uses CO_2 under high pressure and moderate temperature to selectively recover carotenoid-rich oils and oleoresins.

Benefits: Produces solvent-free, highly stable extracts with minimal nutrient loss; parameters can be adjusted to concentrate pigments.

Limitations: High equipment cost; requires process optimization.

Use in lipstick: Ideal for preparing concentrated carotenoid fractions that provide stable pigmentation and antioxidant protection.[48,49,50]

4. Novel Assisted Methods (UAE, MAE, Enzyme-Assisted)

Ultrasound-Assisted Extraction (UAE): Enhances cell wall disruption, accelerates carotenoid release, and shortens extraction time.

Microwave-Assisted Extraction (MAE): Improves solvent penetration and yield under controlled heating.

Enzyme-Assisted Extraction: Breaks down berry cell walls for improved oil and pigment recovery.

Use in lipstick: These methods are emerging as cost-effective and eco-friendly approaches for natural colorant recovery.[51,52]

5. Utilization of Pomace (By-product Valorization)

Context:. Juice and beverage industries leave behind pomace rich in carotenoids, tocopherols, and oils

Benefit: A sustainable and economical source of bioactives for cosmetics.

Use in lipstick: Pomace-derived carotenoid extracts are effective natural pigments and can be encapsulated for stability.[53,54]

Post-Processing for Cosmetic Grade Use

1. Filtration & Clarification: Removes waxes and solids to produce clear, smooth oil.[47]

2. Deodorization: Light steam or vacuum stripping reduces undesirable odors [4].

3. Antioxidant Addition: α-tocopherol or rosemary extract (0.05–0.5% w/w) protects against oxidation.[55]

4. Fractionation: Molecular distillation separates pigment-rich fractions from neutral oil.[48]

5. Encapsulation: Micro- or nano-encapsulation improves stability, prevents oxidation, and enhances color retention.[56,57]

6. Spray Drying: Converts encapsulated oil into powders for easy incorporation in wax bases.[58]

7. Storage: Opaque, airtight containers under inert atmosphere extend shelf life.[59]

Practical Recommendations for Lipstick Formulation

Cold-pressed oil (1–10% w/w) is ideal for emolliency and therapeutic benefits.

SFE carotenoid fractions (0.1–1% w/w) provide intense, stable color.

Always stabilize extracts with antioxidants immediately after extraction.

Encapsulation is recommended for prolonged shelf stability and photoprotection.[2,48,55,56]

Evaluation Parameters Specific to Sea Buckthorn Berry in Lipstick Formulation:

When incorporating sea buckthorn berry (oil or extract) into polyherbal lipsticks, additional evaluation parameters are required to ensure pigment stability, bioactive preservation, and functional performance of the berry-derived components.

1. Carotenoid Content & Stability

Quantification of β-carotene, lycopene, zeaxanthin by HPLC or UV-Vis spectrophotometry to confirm pigment loading.

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Monitoring color stability under light, heat, and storage to assess photodegradation of carotenoids.[60,11]

2. Antioxidant Activity in Lipstick Matrix

DPPH, ABTS, or FRAP assays can be performed on extracts from lipstick samples to evaluate whether sea buckthorn's antioxidant activity is retained after formulation.[26]

3. Fatty Acid Integrity & Lipid Stability

Gas chromatography (GC-MS) analysis of palmitoleic acid, linoleic acid, oleic acid to ensure no oxidative breakdown of lipids in the base.

Peroxide value and thiobarbituric acid reactive substances (TBARS) test can be used for lipid oxidation stability[61]

4. Moisturization & Barrier Function Test

In vitro transepidermal water loss (TEWL) studies or skin hydration measurements (using corneometer) to confirm the moisturizing effect of omega-7 fatty acids present in sea buckthorn [62].

5. Wound-Healing / Regeneration Assays

Scratch assay or keratinocyte proliferation studies (in vitro) can test the healing potential of lipstick extracts containing sea buckthorn oil [63].

6. Photoprotection Assessment

Measurement of sun protection factor (SPF) or UV absorption spectrum of lipstick formulations enriched with sea buckthorn carotenoids.

Helps validate its role as a natural photoprotective pigment [64].

7. Antimicrobial Testing

Agar diffusion or MIC assays against Staphylococcus aureus, Candida albicans, and other oral/lip pathogens to confirm antimicrobial efficacy of sea buckthorn-rich lipstick[65].

8. Organoleptic & Consumer Acceptability

Evaluation of color uniformity, gloss, odor (since sea buckthorn has a distinct fruity note), and smoothness of application.

Sensory studies with volunteers can provide data on acceptance of natural pigments and oil-based emolliency [66].

9. Encapsulation/Release Stability (if used)

If sea buckthorn pigments or oils are encapsulated, tests for release kinetics, encapsulation efficiency, and stability are necessary to confirm functional delivery within the lipstick base[56].

Formulation Challenges and Solutions in Sea Buckthorn-Based Polyherbal Lipstick :

The incorporation of sea buckthorn berry extract or oil into lipstick formulations presents unique challenges due to its complex phytochemistry (carotenoids, flavonoids, fatty acids, vitamins). Addressing these hurdles ensures stability, efficacy, and consumer acceptability of the final product.

1. Stability of Natural Pigments

Challenge: Carotenoids (β-carotene, lycopene, zeaxanthin) and betalains from beetroot are sensitive to light, heat, and oxidation, leading to color fading.

Solution: Use of antioxidants (Vitamin E, rosemary extract), encapsulation techniques (liposomes, nanoemulsions), and dark-colored packaging to enhance stability [11,67].

2. Oxidation of Fatty Acids in Sea Buckthorn Oil

Challenge: Omega-3, 6, and 7 fatty acids are prone to rancidity, affecting odor, taste, and texture.

Solution: Addition of natural stabilizers (tocopherols, ascorbyl palmitate) and cold-pressed oils with controlled processing conditions [61].

3. Compatibility with Wax-Oil Base

Challenge: High oil content (castor, jojoba, sea buckthorn) may soften the lipstick and reduce hardness.

Solution: Adjusting wax concentration (beeswax, carnauba, candelilla) to balance hardness vs. spreadability [68].

4. Strong Odor & Taste of Sea Buckthorn Oil

Challenge: The fruity-tangy odor may not be preferred in cosmetic products.

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Solution: Use of mild natural flavoring agents (vanilla, mint) or deodorized oil fractions during processing [69].

5. Batch-to-Batch Variation in Natural Extracts

Challenge: Variability in bioactive content due to differences in geography, harvesting season, and extraction method.

Solution: Standardization of extracts using HPLC or spectrophotometry to ensure consistent carotenoid/phenolic levels [70].

6. Microbial Contamination Risk

Challenge: Herbal extracts and oils may support microbial growth.

Solution: Incorporation of natural preservatives (grapefruit seed extract, neem, essential oils) and use of GMP conditions [71].

7. Consumer Acceptability of Natural Shades

Challenge: Herbal pigments may not produce the same wide range of shades as synthetic colors.

Solution: Combination of sea buckthorn carotenoids with beetroot betalains or turmeric curcuminoids to achieve diverse shades [72].

8. Photoprotection & Bioactive Delivery

Challenge: Ensuring carotenoids retain UV-protection and antioxidant activity when trapped in a waxy base.

Solution: Nanoemulsions and microencapsulation improve delivery, bioavailability, and functional stability [56].

Regulatory and Safety Aspects of Sea Buckthorn Berry in Polyherbal Lipstick

1. Regulatory Status of Sea Buckthorn in Cosmetics

The European Medicines Agency (EMA) recognizes sea buckthorn oil as a traditional herbal medicine for skin and mucosal healing [73].

In the European Union (EU) Cosmetic Regulation (EC) No. 1223/2009, sea buckthorn oil and extracts are listed as safe cosmetic ingredients when used within recommended concentrations [5].

In the United States, sea buckthorn oil is generally recognized as safe (GRAS status) for food and topical use under the FDA Cosmetic Ingredient Review (CIR) guidelines [6].

According to the Bureau of Indian Standards (BIS), sea buckthorn extracts are permitted in herbal cosmetics provided they comply with microbial limits and heavy metal restrictions [74].

2. Safety Considerations

Dermal Safety: Studies report that sea buckthorn oil is non-irritant and non-sensitizing when used in topical products, making it suitable for sensitive lips [75].

Toxicological Profile: Acute and sub-chronic toxicity studies show no significant adverse effects at cosmetic-use concentrations [76].

Phototoxicity: Carotenoids in sea buckthorn (β-carotene, lycopene, zeaxanthin) provide photoprotection but do not cause phototoxic reactions, unlike some synthetic colorants [77].

Microbial Contamination Risk: As a natural extract, it may carry microbial load; thus, GMP processing, preservatives, and microbial testing are mandatory [78].

Stability & Shelf-life: Carotenoids and fatty acids are prone to oxidation; hence, packaging in opaque containers and use of natural antioxidants (Vitamin E) are recommended [79].

3. Labeling and Claims

Claims like "100% natural," "paraben-free," or "rich in omega-7 and carotenoids" must comply with ISO 16128 guidelines for natural cosmetic ingredients [80].

Any therapeutic claims (e.g., "heals cracked lips") shift the product from cosmetic category to drug regulation, requiring clinical evidence and regulatory approval [6,74].

4. Consumer Safety & Acceptability

Safety assessments should include:

Patch testing on human volunteers for irritation and sensitization.

Heavy metal analysis (Pb, As, Cd, Hg) as per WHO limits for herbal cosmetics.

Microbial load testing (absence of E. coli, S. aureus, P. aeruginosa, Candida albicans).

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Proper safety evaluation builds consumer trust in herbal lipsticks with sea buckthorn extracts [78,79].

Future Prospects of Sea Buckthorn Berry in Polyherbal Lipstick :

Sea buckthorn (Hippophae rhamnoides) holds significant potential for innovation in the cosmetic and cosmeceutical industry, particularly in polyherbal lipstick formulations. Future research and development can focus on the following areas:

1. Enhanced Bioactive Delivery

Development of nanoemulsions, liposomes, or solid lipid nanoparticles for sea buckthorn carotenoids and oils can improve bioavailability, stability, and controlled release in lipsticks [56,81].

Encapsulation technologies can help retain antioxidant and photoprotective properties over extended shelf life.

2. Natural Color Intensification

Combining sea buckthorn carotenoids with other herbal pigments (beetroot, hibiscus, turmeric) can produce vibrant, long-lasting shades without synthetic dyes [11,4].

Exploration of pigment fractionation to create standardized color intensities suitable for commercial production.

3. Functional Lipsticks (Therapeutic & Protective)

Future formulations can focus on "cosmeceutical lipsticks" that provide anti-aging, photoprotective, antimicrobial, and wound-healing benefits [1].

Omega-7-rich sea buckthorn oil can be positioned as a therapeutic ingredient in lip care products.

4. Sustainable and Eco-friendly Production

Valorization of pomace and by-products from sea buckthorn juice industries for lipstick pigments and oils supports zero-waste and sustainable cosmetic production [82].

Cold-pressing and supercritical CO_2 extraction are environmentally friendly techniques that align with green cosmetic trends.

5. Standardization and Quality Control

Future research should focus on standardization of sea buckthorn extracts for carotenoid, flavonoid, and fatty acid content.

This ensures batch-to-batch consistency and regulatory compliance, which is crucial for commercialization [83].

6. Clinical and Consumer Studies

Conducting clinical trials and human sensory studies can validate moisturizing, healing, and photoprotective claims.

Consumer acceptability studies can guide the optimization of color, texture, and fragrance in sea buckthorn-based lipsticks [84].

7. Innovative Formulation Approaches

Combining sea buckthorn extracts with smart wax blends, herbal oils, and natural antioxidants can create customizable lipsticks targeting specific skin types, climates, or age groups [85].

Use of 3D printing or modular lipstick bases could allow for personalized lip care products enriched with sea buckthorn bioactives.

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