

### Unit 2: Raw Materials and the Design of Herbal Cosmetic Formulations

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#### 2.1 Commonly used herbal cosmetics and their raw materials in outline

Unit 2 opens with the commonly used herbal cosmetics, which are simply the product classes of Units 3 and 4 in their herbal form: herbal cleansing creams and lotions, herbal face packs and powders, herbal soaps and shampoos, herbal hair oils and colorants, herbal dentifrices and mouth washes, and herbal creams for moisturizing and complexion care. What makes them one unit is that they are all built from the same short shelf of raw material families, and a formulator who commands the families can read any product in the classes. The families are: the water and aqueous phase materials; the oils, fats and waxes that form the lipid phase and the skin feel; the surfactants that cleanse and emulsify; the humectants that hold water; the preservatives that keep the product safe in its container; the colours; the fragrances and volatile oils; the thickeners and structuring agents that give body; and the functional herbs and extracts that give the product its herbal identity and its intended surface action. The next six sections take the syllabus families in its own order, preservatives, surfactants, humectants, oils, colours and functional herbs, after one general rule: every raw material enters the formulation with a specification, identity, purity and quality in the sense of MPG202T, and a herbal extract is a raw material like any other, standardised by its marker or its fingerprint, never a handful of tradition added by weight of reputation.

#### The cosmetic ingredient families

| STRUCTURE AND FEEL                                                                                                         | WATER AND SAFETY                                                                                                                                | IDENTITY                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Oils, fats and waxes:<br>the lipid phase<br>Surfactants: cleansing<br>and emulsifying<br>Thickeners: body<br>and stability | Water: the vehicle<br>Humectants: hold water<br>in product and on skin<br>Preservatives: guard<br>the aqueous phase<br>Antioxidants: guard oils | Colours: dyes,<br>pigments and lakes<br>Fragrances and<br>volatile oils<br>Functional herbs:<br>extracts, standardised |

Every product in Units 3 and 4 is a selection from this one shelf

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Figure: The ingredient families of Unit 2. Every product in Units 3 and 4 is a selection from this one shelf, proportioned to its tissue and its task.

#### 2.2 Preservatives

A cosmetic that contains water and nutrients, which is to say nearly every cream, lotion, shampoo and pack in this subject, will grow micro-organisms unless it is preserved, and a contaminated cosmetic is both an efficacy failure and a safety hazard on skin that may be broken or shaved. Preservatives are the antimicrobial ingredients added to prevent that growth in the container during manufacture, storage and consumer use. The standard teaching classifies them by chemistry and by spectrum: antibacterial agents, antifungal agents, and the broad agents used against both, with antioxidants taught beside them as the second preservation system, since oils and fragrances fail by oxidation as surely as aqueous products fail by infection, and the two systems are often confused by students. An antioxidant protects the product from

air; an antimicrobial preservative protects it from life; a rancid cream and a mouldy cream are different failures needing different guards.

Selection follows principles, not habits. The preservative must be effective against the organisms the product will actually meet, at the pH and in the phase system of that product, since many preservatives work only in the water phase and only within a pH range; it must survive the process and the shelf life without reacting with the other ingredients; it must be permitted for cosmetics in the governing rules and used within its permitted conditions; and it must be safe at the site of use, which is why the eye area, lips, baby products and leave on products draw stricter choices than rinse off products. Two herbal cautions belong here. Plant extracts can carry a heavy microbial load into the batch, so the herbal formulator preserves for the load actually present, not the load a clean synthetic base would carry. And no traditional antimicrobial reputation of an herb replaces the preservative efficacy test of Unit 5: the product is preserved when the test says so, not when the label names a famous plant.

## 2.3 Surfactants

Surfactants, surface active agents, are the working molecules of cosmetic science: each carries a water loving head and an oil loving tail, so the molecule sits at surfaces and interfaces and changes what happens there. From that one structure flow all their cosmetic jobs: wetting a surface so water spreads on it, emulsifying oil and water into the creams and lotions of this subject, dispersing solids, solubilising fragrances and oils into clear products, foaming, and above all cleansing, in which surfactant molecules surround oily soil and skin debris in micelles and lift them into the rinse water. The classification the examination expects is by the charge of the head group. Anionic surfactants, negatively charged, are the main cleansers of shampoos, soaps in the syndet sense and dentifrices, strong in detergency and foam. Cationic surfactants, positively charged, are poor cleansers but excellent conditioners, because the positive head is attracted to the negatively charged damaged hair surface, which is why they rule the conditioner class of Unit 4. Nonionic surfactants, uncharged, are mild, stable emulsifiers and solubilisers used across creams and lotions. Amphoteric surfactants, carrying both charges according to pH, are the mildness partners blended into shampoos and baby products to soften the anionics. Soap itself, the oldest surfactant, is treated fully in Unit 3.

Performance is judged on the properties the structure predicts: cleansing power, foam quantity and quality, mildness to skin and eye, behaviour in hard water, compatibility with the other ingredients, and stability across the product's pH and temperature range. The formulation lesson is that surfactants are chosen as systems: a primary cleanser for soil removal, secondary surfactants for foam and mildness, and emulsifying surfactants where the product is a cream rather than a wash, each decision following from the tissue and task of Unit 3.

| Surfactant class | Charge of head group | Typical cosmetic role                              | Character the formulator uses                       |
|------------------|----------------------|----------------------------------------------------|-----------------------------------------------------|
| Anionic          | Negative             | Primary cleansing in shampoos, washes, dentifrices | Strong detergency and foam, needs mildness partners |
| Cationic         | Positive             | Conditioning of hair, antistatic action            | Substantive to damaged hair, poor cleanser          |
| Nonionic         | None                 | Emulsifying creams and lotions, solubilising       | Mild, stable, low foam                              |
| Amphoteric       | Both, pH dependent   | Mildness partner in shampoos and baby products     | Softens anionic systems, good skin feel             |

## 2.4 Humectants

Humectants are the water holding ingredients: hygroscopic materials that attract water and hold it where they are placed. In a cosmetic they work in two theatres at once. Inside the container they keep the product itself from drying out, so creams do not crust and pastes do not harden. On the skin and hair they hold water in the surface layer, which is the whole physical basis of moisturizing as Unit 4 teaches it: the stratum corneum feels soft and looks smooth in proportion to the water it holds, and a humectant film slows the escape of that water to dry air. The standard members of the class are the polyols and allied materials of the cosmetic shelf, glycerol (glycerin) first among them, with propylene glycol, sorbitol and related polyhydric alcohols, and the natural moisturizing factor type materials in the wider teaching. Several are also useful solvents and sweeteners in oral products, which is why the humectant reappears in dentifrices in Unit 3, keeping the paste moist in its tube and pleasant in the mouth.

Judgement of a humectant is by water holding behaviour across humidity, by feel, since the class runs from clean to tacky as concentration rises, by compatibility, and by the product type: a leave on cream can carry the humectant load that a rinse off product would simply wash away. The interaction with preservation should be noted now and used in Unit 5: a sufficiently high humectant and polyol content lowers the available water of a product and so assists its microbial defence, one of the few places where two ingredient families pull in the same direction.

## 2.5 Oils, fats and waxes

The lipid shelf supplies the body, the skin feel and much of the stability of cosmetic products. Fixed oils, vegetable oils such as coconut, almond, sesame, olive and castor oils in the standard teaching, and mineral oil from the petroleum shelf, serve as emollients that spread on skin and hair, soften the surface, carry oil soluble ingredients, and form the internal or external phase of emulsions. Fats and butters of the shea and cocoa type give body and melting behaviour near skin temperature. Waxes, beeswax and the plant and mineral waxes, structure the product: they stiffen sticks such as lipsticks, thicken creams, and stabilise emulsions by building a solid network. Volatile oils, the essential oils of pharmacognosy, belong functionally to fragrance and to the functional herb shelf as much as to the oils, and are treated in Section 2.7.

Each lipid is judged by the properties the examination names for raw materials generally: its spreading and feel, its stability against rancidity, since an oxidised oil ruins odour, colour and skin tolerance together, its purity and constants in the pharmacognostic sense, and its compatibility with the emulsion system chosen. The herbal formulator's characteristic oils are the infused and expressed plant oils that carry the identity of the product, herbal hair oils being the type example of Unit 4, and their discipline is the same as any oil's, with the added duty of standardising what the plant has put into them.

## 2.6 Colours

Colour is a functional ingredient in cosmetics, not a decoration added at the end: it gives lipsticks and face powders their whole purpose, tints creams and soaps to their expected appearance, and signals identity and flavour in oral products. Cosmetic colours are classified by source and by behaviour. By source they divide into mineral and inorganic pigments, plant and natural colours, and synthetic colours permitted for cosmetics. By behaviour they divide into soluble dyes, which dissolve and colour transparently, and insoluble pigments and lakes, which disperse as fine particles, give opacity and covering power, and are therefore the colours of lipsticks, powders and foundations. The natural colour shelf of this subject includes the plant colours long used in Indian practice, among them turmeric for yellow, henna for its reddish brown staining of hair and skin, indigo in hair colouring, and the annatto, saffron, madder and beetroot type colours of the traditional list, each taught by source, colouring principle in general terms, and use, without invented technical claims.

Colour judgement is strict because colour faults are visible to every buyer: identity and purity of the colour material, its stability to light, heat and the product's pH, its even dispersion without streaking or bleeding, and above all its permission. Only colours permitted for cosmetics in the governing rules may be used, with stricter lists for products used near the eyes and on the lips, and a traditional history does not by itself place a colour on the permitted list: henna's long use coexists with the modern duty to control its purity and to exclude adulterated black henna type products that add undeclared chemicals. That sentence states the whole colour doctrine of the subject.

## 2.7 Functional herbs

Functional herbs are the plant materials included for the action the product is built around, as against herbs present only as fragrance or colour. The standard teaching meets them in families by cosmetic task: herbs used for skin cleansing and complexion care, herbs used for hair growth, conditioning and colouring in traditional practice, herbs with astringent and toning character used in tonics and packs, herbs used in oral care, and aromatic herbs and volatile oils used across all of these. Named examples recur through the Indian cosmetic tradition and the examination literature: aloe, turmeric, neem, amla, bhringraj, henna, shikakai and reetha type washing materials, sandalwood, liquorice, brahmi and hibiscus among them, each to be known by its part used, its traditional cosmetic role stated as traditional use, and its form in commerce, as powder, extract or oil. Two rules govern everything said about them in these notes. Their traditional roles are recorded as the tradition states them, which is their correct standing, and no efficacy claim is made for any product containing them. And as raw materials they face the full standardisation discipline of MPG202T and MPG103T: identity by the pharmacognostic characters, quality by marker or fingerprint where established, and control of the microbial, heavy metal and pesticide burden that a field grown material can carry into a cosmetic.

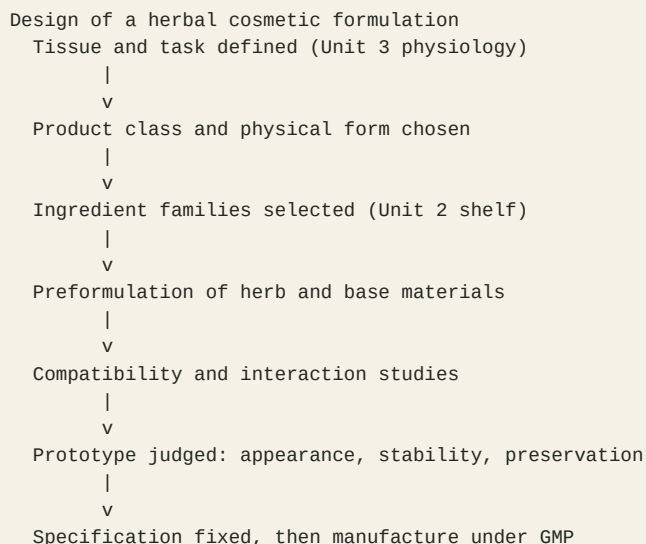
## 2.8 Preformulation studies

Preformulation is the study of a planned formulation's materials before the formulation is fixed, so that the design decisions of the next section rest on measurement rather than hope. For herbal cosmetics the studies follow the pattern the student knows from pharmaceuticals, fitted to cosmetic materials. The herbal raw material is characterised: identity, organoleptic characters, solubility behaviour of the extract, its colour and odour contribution, its pH in solution, its stability to heat, light and air, and its marker content where a marker exists. The base materials are characterised in parallel: the emulsion or surfactant system the product will use, its pH range, its viscosity behaviour and its own stability. Then the two are brought together in trial mixtures at bench scale and watched: does the extract break the emulsion, shift the colour, thin the product, precipitate, or darken on standing? Preformulation answers these questions cheaply, in beakers, before they can be asked expensively, in filled jars. Its output is not a product but a set of decisions: which extract form to use, which base family tolerates it, which pH window the product must hold, and which risks the compatibility studies must now pursue formally.

## 2.9 Compatibility studies and chemical and herbal interactions

Compatibility studies test the chosen combination over time and under stress: the prototype product is stored at room and elevated temperatures, exposed to light where the pack allows it, cycled where transport demands it, and examined at intervals for the faults preformulation predicted, separation, colour and odour change, pH drift, viscosity change, loss of marker or preservative failure. Possible interactions between chemicals and herbs, the syllabus's own phrase, deserve a section of their own because they are the characteristic scientific risk of this subject. The interaction families are standard and should be listed in any examination answer. Physical interactions: a plant extract precipitates with an ingredient, salts out an emulsion, or adsorbs onto powders and clays so the product separates or loses its active distribution.

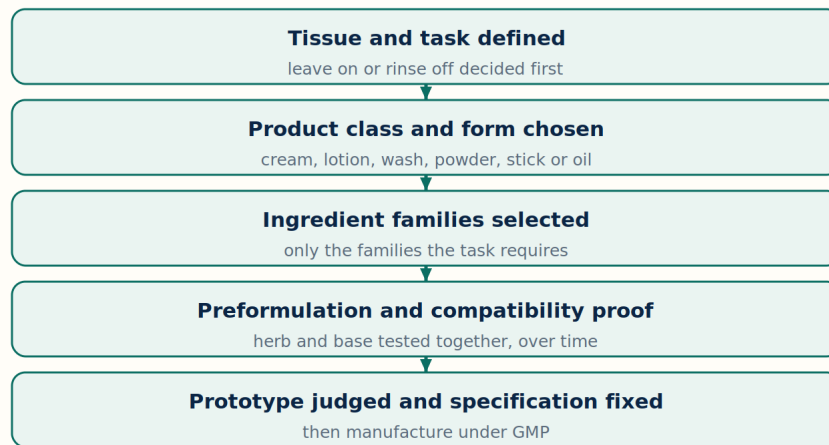
Chemical interactions: acidic or alkaline herb constituents shift the product pH and so disable a pH dependent preservative or colour; tannin rich materials darken with iron and react with proteins and alkaloidal materials; oxidisable plant constituents consume the antioxidant and then discolour the product themselves. Functional interactions: a herb constituent binds inside surfactant micelles and is no longer available at the surface, or an ingredient inactivates the very constituent the product is sold for. And biological interactions in the safety sense: a combination produces irritation or sensitisation that neither part produced alone, which is why Unit 5 tests the finished product and not only its parts.



## 2.10 Design of herbal cosmetic formulation

Design is the disciplined assembly of the unit: the tissue and task come first, then the product class and physical form, then a selection from each ingredient family that the task requires and no family it does not, then preformulation, compatibility proof, prototype judgement and specification. The design questions, in the order a formulator answers them, are the real syllabus of this section. What surface, in what condition, for how long: leave on or rinse off decides half the ingredient choices at a stroke. What must the product visibly and measurably do: cleanse, condition, moisturize, colour or control odour, stated as testable performance. Which herbal material carries the product's identity, in which standardised form, and what does it bring with it in colour, odour, pH and load? Which base system carries it without interaction, at which pH, preserved how, packed in what, stable for how long under the stability discipline of Unit 5? A formulation that can answer those questions in writing is designed; a mixture that cannot is only assembled. With the shelf and the method in hand, the subject now turns to the tissues themselves.

## Design of a herbal cosmetic formulation



A formulation that answers these questions in writing is designed, not assembled

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Figure: Formulation design as a sequence of answered questions. The specification at the end is only as good as the preformulation and compatibility work before it.

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