CHEMISTRY OF COSMETICS AND FOOD PROCESSING

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I. CHEMISTRY OF COSMESTICS AND PERFUMES

- **Cosmetics** are substances or products used to enhance or alter the appearance of the face or fragrance and texture of the body. Many cosmetics are designed for use of applying to the face, hair, and body. They are generally mixtures of chemical compounds; some being derived from natural sources (such as coconut oil), and some being synthetics or artificial.

Lipstick:

I

- First, the raw ingredients for the lipstick are melted and mixed—separately because of the different types of ingredients used.
- One mixture contains the solvents, a second contains the oils, and a third contains the fats and waxy materials. These are heated in separate stainless steel or ceramic containers.

II

- The solvent solution and liquid oils are then mixed with the colour pigments.
- After the pigment mass is prepared, it is mixed with the hot wax.

III

- The mixture is agitated to free it of any air bubbles. Then it is poured into tubing moulds, cooled, and separated from the moulds.
- After final touch-up and visual inspection, the lipstick is ready for packaging.

Shampoo:

I

- The primary ingredient in all shampoos is Deionized water which is heated to about 65oC along with preservatives.

II

- The next most abundant ingredients in shampoos are the primary detergents(sodium lauryl sulfate, sodium lauryl ether sulfate) and heated at 65o C

III

- In addition to cleansing surfactants, other types of surfactants are added to shampoos to improve the foaming characteristics of the formulation.

IV

- The solutions are mixed together and then cooled. Then you will need to add the perfumes.Thus, you will get the finished shampoo.

V

- Then the shampoo goes to the bottling and packaging area.After a shampoo formula is developed, it is tested to ensure that its qualities

Hair spray:

I. Batching:

- During the manufacturing process the formula is prepared as a liquid concentrate in large tanks. The tanks are equipped with a large turbine mixer.
- The solvent is charged into the tank first and then followed by the other ingredients. The solvent makes up the largest proportion of the formula and may be present at 80% by weight or greater. Other ingredients range in concentration from a few tenths of a percent for some of the pH control agents, to a few percent for fragrance, to approximately 10% for the resin. Depending on the solubility of the ingredients in given formula, this mixing step may take as little as 30 minutes or as long as several hours. Since some of the ingredients are in the form of powders, the mixture must be carefully monitored during the batching process to ensure they dissolve properly.
- After mixing is complete the concentrate is tested to ensure it conforms to specifications and is then transferred to a holding tank prior to filling.

II. Filling

1.The packaging components are staged on the filling machinery. As the empty cans move down the conveyor belt, a jet of compressed air removes any dirt and dust.

2.At the next stage of the filling line, there are a series of nozzles, known as filling heads, that are connected to tubes that transfer the liquid concentrate from the tank where it is stored. A piston mechanism injects a precise amount of liquid into the can.

3.The cans proceed down the line to the next station where two actions occur at once. The gaseous propellant is shot into the cans and the valve cup is immediately crimped into place. The metal cup is crimped onto the rim on the opening of the can. This tight seal prevents the gas and liquid from leaking out.

5. After the gassing operation the cans are fed through a long trough filled with hot water. As the cans slowly move underwater they are checked visually for escaping bubbles, which would indicate a bad valve seal or a leaky can. Leaking cans are removed during this stage of the operation.

6 .After exiting the water-bath, cans are dried by compressed air jets. A cap is placed over the valve at the end of the filling line; this prevents the aerosol from being accidentally activated during shipping.

7. Finally the finished units are packed into boxes and stacked on pallets for shipping.

Hair dye:

- Before a batch of hair dye is made, the ingredients must be certified. That is, the chemicals must be tested to make sure they are what they are labeled.
- Certification may be done by the

I. Checking ingredients.

II. Weighing

- Next a worker weighs out the ingredients for the batch. For some ingredients, only a small amount is necessary in the batch. But if a very large batch is being made, and several ingredients are needed in large amounts, these may be piped in from storage tanks.

- In some hair dye formulas, the dye chemicals are pre-mixed in hot water. The dye chemicals are dumped in a tank, and water which has been already heated to 158°F(70°C) is pumped in. Other ingredients or solvents may also be added to the pre-mix. The pre-mix is agitated for approximately 20 minutes.

III. *Pre-mixing*

IV. Mixing

- The pre-mix is then added to a larger tank, containing the other ingredients of the hair dye. A worker wheels the pre-mix tank to the second mix tank and pours the ingredients which are connected by pipes.
- In a formula in which no pre-mixing is required, after checking and weighing, the ingredients go directly to the mixing step. The ingredients are simply mixed in the tank until the proper consistency is reached.
- If a heated pre-mix is used, the second mix solution must be allowed to cool. The ingredients that follow the pre-mix may be additional solvents, surfactants, and alkalizers. If the formula includes alcohol, it is now added until the mix reaches 104°F(40°C), so that it does not evaporate. Fragrances too are often added at the end of the mix.

V. Filling

- The finished batch of hair dye is then piped or delivered to a tank in the filling area. A nozzle from this tank lets a measured amount of hair dye into bottles.

VI. Packing

- The filled bottles continue on the belt to machines, which affix labels ,capped & packed.

Sunscreen lotion:

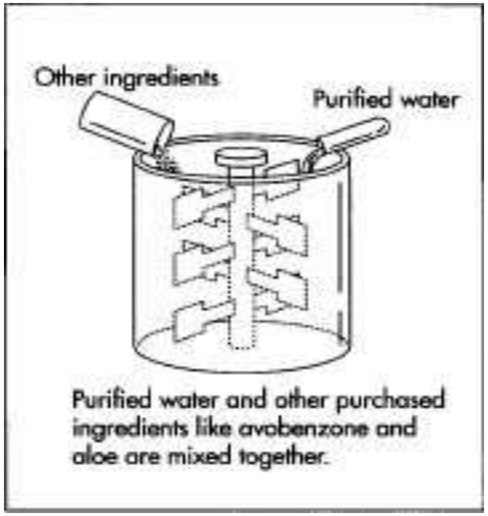
- **Raw Materials:**
- Many combinations of synthetic and natural ingredients may go into the formulation of a single sunscreen. A formulation is generally geared towards a specific SPF rating or the needs of a specific consumer group. Perhaps the best-known synthetic material used for protection against UVA rays is avobenzone, or Parsol 1789, which is used in products worldwide. Broad spectrum protection is provided by other synthetic ingredients such as benzophenone and oxybenzone, which protect by absorbing UV light. PABA (paraaminobenzoic acid) was once a popular UV-absorbing sunscreen ingredient, but it can cause skin irritation in some people and is now replaced by Padimate-O, a derivative of PABA. Other broad spectrum synthetic ingredients are octyl methoxycinnamate and menthyl anthranilate.

- Titanium dioxide is a natural mineral and a popular ingredient for broad spectrum protection. Titanium dioxide works by scattering UV light instead of absorbing it. Although not as opaque as zinc oxide, it has a similar whitening effect in the higher SPF ratings. Antioxidants are often combined with titanium dioxide to slow down the oxidation of oils and thereby delay the deterioration of the lotion. Some examples of natural antioxidants are vitamins E and C, rice bran oil and sesame seed oil. Another popular antioxidant in the natural category is green tea. Many newer sunscreen products also contain skin soothing and moisturizing additives such as aloe and chamomile.

Formulating the lotion:

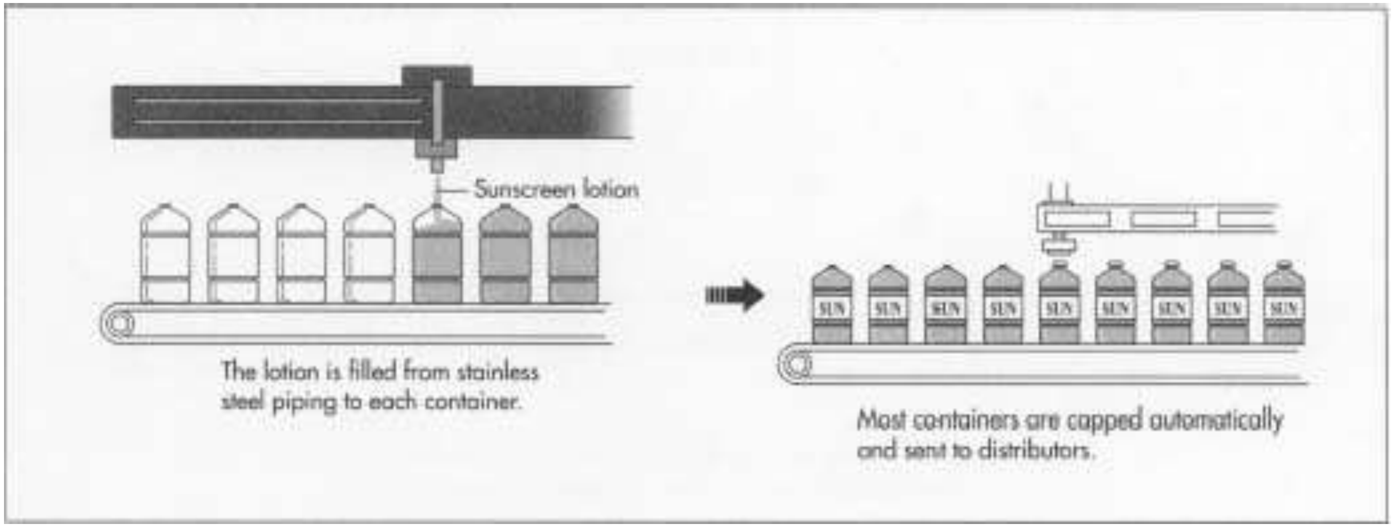
- Water is purified using a method called reverse osmosis.

- Ingredients are purchased from outside sources and mixed with the purified water according to the recipe of the final formulation. The recipe is recorded on a vat sheet which lists the exact measurements for each ingredient. Measurements are converted from the initial 10-gallon (38 1) recipe used in the development stage to larger quantities for commercial use.



➢ *Filling the containers:*

Stainless steel tanks with capacities up to 1,000 gallons (3784 1) are used in the filling process. Filling takes place in a separate, sterile room with a conveyor system of many incoming tracks. Machine operators monitor the automated process. Containers and caps enter the fill room on conveyor tracks. The sunscreen lotion flows from the vats through stainless steel piping to a pressure filling machine which inserts a retractable nozzle into each container and fills it with a measured amount of sunscreen lotion.



Shaving cream:

- Raw materials:
- Standard recipe contains approximately 8.2 percent stearic acid, 3.7 percent triethanolamine,. 5 percent lanolin, 2 percent glycerin, 6 percent polyoxyethylene sorbitan monostearate, and 79.6 percent water.

1.

- In the first phase, the fatty or oily portions of the formula—stearic acid, lanolin, and polyoxyethylene sorbitan monostearate—are heated in a jacketed kettle to a temperature of approximately 179 to 188 degrees. Inside the interior kettle are blades that revolve to mix the oils as they are heated.

2.

- After the first group of ingredients has turned smooth over a period of roughly 40 minutes, the steam is released from the kettle, and the mixture is allowed to cool.

3.

- The second phase of manufacture begins when the mixture has cooled to about 152 degrees. Most of the remaining ingredients—water, glycerin, and triethanolamine—are added now, and mixing continues for approximately 40 minutes.

4.

- When the mixture reaches a temperature of 125 to 134 degrees, perfumes or other scents can be added.

5.

- The mixture, still being stirred, is allowed to cool further, until it reaches a temperature of 89 degrees. Now a thickening white mass of highly viscous liquid, it is forced through a silk or **stainless steel** screen to eliminate any lumps that may have formed in the mixing process, and to catch the rare impurity or foreign object such as a small wood splinter.

6.

- If this particular mixture is designated for tube packaging, it is now placed in a tube and fitted with a cap. After the bottom of the tube has been crimped, the product is ready for shipment and stocking on a store shelf.

Talcum powder:

Talc or **talcum** is a clay mineral composed of hydrated magnesium silicate.

Initially the perfume is mixed with the absorbent properly it is mixture A kept aside.

Deodorants are added to enrich antiseptic properties to the powder. Here, the perfume develops the scent.

Talc, kaolin, colloidal silica, aluminium sterate and magnesium sterate mixed properly it is mixture B.

The mixture A is mixed with mixture B and mixing is carried out properly.

Finally pack the powder in a suitable container.

Nail enamel:

- Nail polish consists of a film-forming polymer dissolved in a volatile organic solvent. Nitrocellulose that is dissolved in butyl acetate or ethyl acetate is common. This basic formulation is expanded to include the following:[7]
- Plasticizers to yield non-brittle films. Dibutylphthalate and camphor are typical plasticizers.
- Dyes and pigments. Representative compounds include chromium oxidegreens, chromium hydroxide, ferric ferrocyanide, stannic oxide, titanium dioxide,iron oxide, carmine, ultramarine, and manganese violet.[8]
- Opalescent pigments. The glittery/shimmer look in the color can be conferred by mica, bismuth oxychloride, natural pearls, and aluminum powder.
- Adhesive polymers ensure that the nitrocellulose adheres to the nail's surface. One modifier used is tosylamide-formaldehyde resin.[9]
- Thickening agents are added to maintain the sparkling particles in suspension while in the bottle. A typical thickener is stearalkonium hectorite. Thickening agents exhibit thixotropy, their solutions are viscous when still but free flowing when agitated. This duality is convenient for easily applying the freshly shaken mixture to give a film that quickly rigidifies.

Vanishing cream and cold cream:

- Vanishing cream leaves no trace when rubbed on face. Its an emulsion of oil in water.
- Cold cream leaves behind a cooling effect on skin . Its an emulsion of water in oil.
- Vanishing creams are more easily washed off and maintained in comparision with cold creams as its harder to wash off an oil phase.

PREPARATION:

- **Vanishing cream:**
- Steric acid.
- An alkali(like KOH).
- A Polyol (like glycerine).
- Water in major content.
- **Production:**
- The alkali reacts with some of the steric acid to form a soap, which then acts as an emulsifier.
- The polyol (glycerine) prevents the loss of moisture.
- Sodium sterate crystals gives pearly shine.

- STEP 1: Melt stearic acid
- STEP 2: Mix water, NaOH and glycerin and heat to same temperature as stearic acid.
- STEP 3: Mix both the melts together and stir till it becomes creamy.
- **Cold cream:**

- Bees wax acts as base for the cream.
- Borax is used as preservative.
- Mineral oil.
- Water
- Borax.
- Perfume.

- Special ingredients:
- Alpha hydroxy acids (lactic acid):

They help removing:

- Fine lines.
- Irregular pigmentation.
- Age spots.
- Beta hydroxy acids(salicylic acid):
- Removes dead skin cells and improve texture.
- Helps with removing acne.

- Hydro quinone:
  - Used in lightening dark spots and age spots.
  - Hence are also called bleaching or ligthening agents.
- Kojic acid:
  - It is derived from a fungus and slows the production of melanin(brown pigment).
  - Works similarly to hydroquinone.
- Retinol:
  - Helps improve skin texture and tone.
  - Removes fine lines and wrinkles.
  - It is also one of the best anti ageing mineral.

- L- ascorbic acid:

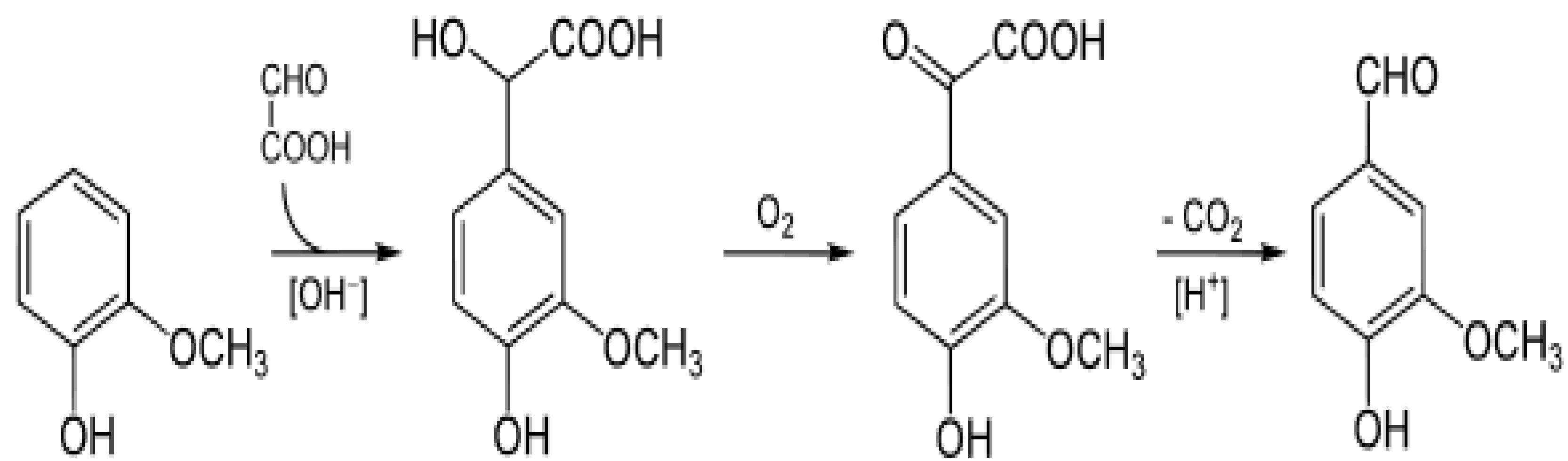
It is one of the forms of vitamin C with agents sunexposure collagen synthesis in skin diseases leading to wrinkles.

The fundamental differences between natural and artificial flavors:

- Natural flavors are typically complex mixtures of chemicals derived from plants or fruits. In many cases there will be one predominant flavor chemical, as well as dozens, or even hundreds of other components. It is this complex mixture that gives natural extracts a richer, more complex flavor. But it is usually the predominant flavor chemical that will be identified by someone's sense of taste or smell. By contrast, an artificial flavor is synthesized from other chemicals rather than being extracted from a natural source. Artificial flavors usually contain only a small number —often just one — of the same flavor chemicals found in the natural extract, but lack the others so they cannot precisely duplicate the flavor of the complex mixture. So, while someone tasting an artificially flavored food will be able to identify the principal flavor, it may seem bland or taste like it is "missing something." Some are better than others, so we'll discuss a few. Vanilla will be our first test case because it's relatively simple and many people like it.

PREPARATION OF ARTIFICIAL FLAVOUR:

- **PREPARATION OF VANILLIN:**
- Today most vanillin is produced from the petrochemical raw material guaiacol.[9] Several routes exist for synthesizing vanillin from guaiacol.[31]
- At present, the most significant of these is the two-step process practiced by Rhodia since the 1970s, in which guaiacol (**1**) reacts with glyoxylic acid by electrophilic aromatic substitution.[32] The resulting vanillylmandelic acid (**2**) is then converted via 4-Hydroxy-3-methoxyphenylglyoxylic acid (**3**) to vanillin (**4**) by oxidative decarboxylation.[4]



1 2 3 4

Anti perspirants

- Antiperspirants help to reduce the production of sweat. Aluminium salts – the active ingredient found in antiperspirants – dissolve into the moisture on the skin's surface. This forms a gel, which temporarily sits on top of the sweat gland, reducing the amount of sweat released.
- Antiperspirants that contain alcohol also help the active ingredient to dry faster and create a pleasant, cool feeling.

- An antiperspirant can also be a deodorant, because it can help to control sweat and contain a fragrance at the same time. But deodorants only mask body odour; they don't help to prevent sweating.
- To combat body odour, some antiperspirants also contain antimicrobials that work to kill the bacteria that cause BO. Slowing the reproduction of these bacteria neutralises bad smells, so you stay fresher for longer. Some antiperspirants also contain added skin conditioners that make your underarms feel soft.

Preparation of anti perspirant

- The formulation and ingredients vary according to whether the product is to be supplied in aerosol, roll-on, gel or stick form, however to some extent the basic manufacturing process is the same:
- The vessel is charged with solvents such as alcohol, propylene glycol, glycerine, etc. or silicones such as dimethicone. This is the oil or "continuous phase."
- Flake/powder ingredients, such as cetyl alcohol are dispersed into the oil phase.
- The "dispersed phase" is prepared separately. Typically this is aqueous, however stick deodorants usually do not contain water; the dispersed phase would also be oil based.
- The active ingredient is dispersed into this phase. Suspending agents such as bentonite may be added.
- The phases are combined to form an emulsion.
- The active ingredient is sometimes added at this later stage.
- Gelling agents or polymers are added to stick products to form structure.
- Fragrance and coloring are added.
- The product is cooled and poured into containers, moulds, etc.

- Essential oils are widely incorporated in cosmetic products, perfumes and related household products due to the variety of their properties but mainly due to their pleasant odour. The composition of these volatile natural complex mixtures may vary depending on the quality of plant material from which they were obtained and the extraction method by which they were derived. These factors are also important in ensuring the safe use of essential oils in personal care products.
- Essential oils as well as their isolated compounds are widely used in cosmetic products as they offer a variety of benefits. Their biological activities range from analgesic, antiseptic, antimicrobial, carminative, diuretic, spasmolytic to hyperaemic and stimulatory. The main reason for their usage in cosmetics is their pleasant aroma. Fatty acids, fatty oils and surfactants used in the production-process of cosmetic products often exhibit an unpleasant scent. Effective perfume mixtures are therefore added to these products in order to mask it. If such a product is not explicitly labelled as “fragrance-free”, “contains no perfume” or “scented-free” it can be assumed that it contains fragrance chemicals [1]. There is a variety of cosmetic and personal care products on the market for the purpose of cleaning, nourishing, beautifying and perfuming of the human body in order to protect and retain improved condition of the body and to promote its attractiveness.

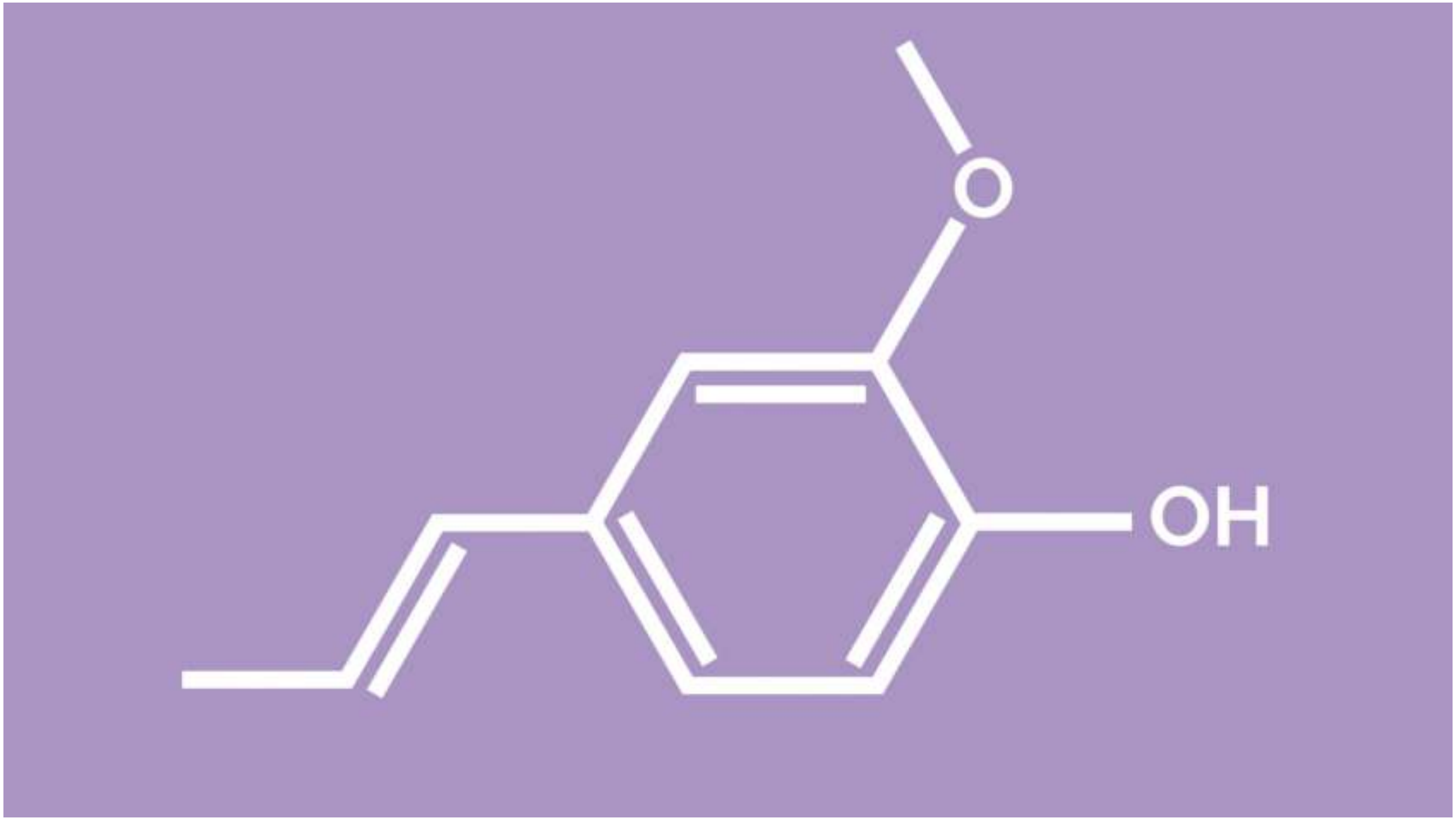
Essential oils and other ingrediants used in cosmetics

- Lavender Essential Oil.
- Peppermint Essential Oil.
- Sandal wood oil.
- Rosemary Essential Oil.
- Rose Oil.
- Tea Tree Oil.
- Eugenol.
- Geraniol.
- Eucalyptus .
- 2-phenyl ethyl alcohol.

Eugenol

- Eugenol is a clear to pale yellow liquid that has a spicy clove-like aroma. Eugenol, a naturally occurring substance found in many plants, is used to make fragrances and flavors. In cosmetics and personal care products, Eugenol is used in the formulation of aftershave lotions, bath products, bubble baths, fragrances, hair care products, moisturizers, shampoos and skin care products.

structure of eugenol



Geraniol

- Geraniol is a clear to pale-yellow oil with a rose-like odor. In addition to being used as a fragrance ingredient, Geraniol is also used in flavors such as peach, raspberry, plum, citrus fruits, watermelon, pineapple and blueberry. In cosmetics and personal care products, Geraniol is used in the formulation of aftershave lotions, bath products, bubble baths, hair products, lipsticks, moisturizers, perfumes and colognes, skin care products and suntan products.

eucalyptus

- Eucalyptus Essential Oil’s active chemical components contribute to its reputation as a purifying, cleansing, clarifying, and immune-boosting oil that is ideal for use on skin and in aromatherapy. It is known for its ability to reduce or eliminate harmful surface and airborne bacteria, and infections upon contact.
- The main constituents of Eucalyptus Oil are: α-Terpineol, 1,8-cineole (Eucalyptol), α-pinene, β-pinene, Sabinene, Camphene, Limonene, p-Cymene, Camphor, Globulol, Citronellal, α-phellandrene, Aromadendrene, and Piperitone.

- When used cosmetically to nourish hair, Eucalyptus Essential Oil will moisturize an itchy scalp and remove dandruff flakes. As a natural insecticide, it is even known to have the ability to eliminate lice. This germicidal oil’s antiseptic properties make it a popular choice for use on wounds, cuts, burns, bites, stings, and sores. Besides soothing the irritated skin, it relieves pain, protects any openings from becoming infected, and promotes faster healing. Added to warm baths, Eucalyptus Essential Oil’s analgesic and anti-inflammatory properties help to rejuvenate stiff and sore muscles.

2- phenyl ethyl alcohol

- Phenylethyl alochol is a higher aromatic alcohol characterized by a delicate fragrance of rose petals starting at 20 ppm. Ahove 40 ppm, this aroma becomes an undesirable in foods. Generally, the higher alcohols are quantitatively the largest group of volatile compounds and their presence is essential to the overall flavor quality. These alcohols also can play indirect roles as precursors in the preparation of other flavorants. For example, alcohols can be oxidized to aldehydes or used for the production of esters.
- Phenylethyl alcohol followed ethyl alcohol as the main commercial alcohol. It is the most used fragrance in the perfume and cosmetic industries. It is found in the composition of numerous perfumes in various proportions, from 5-20%. With regard to its world consumption, several studies have come up with the figure of 7,200 metric tons per year; however, in foodstuffs (1-3 ppm in soft drinks, candy and cookies), the consumption is estimated at only 10 metric tons per year.
- It is added to modify certain flavor compositions, especially fruit formulas, where it contributes organoleptically.

FOOD PROCESSING :

- Methods for food processing :-
- Food processing and preparation activities cover three main fields: (1) the preservation of foods by (a) modern methods such as refrigeration, **canning** and irradiation, and (b) traditional methods such as **drying**, **salting**, **smoking** and**fermentation**; (2) the development of protein - rich foods; (3) food additives.

Additives and preservatives.

- Additives and preservatives are used to maintain product consistency and quality, improve or maintain nutritional value, maintain palatability and wholesomeness, provide **leavening**, control pH, enhance flavor, or provide color. **Food additives** may be classified as:

Additives and preservatives in food processing.

- Additives are defined by the United States Food and Drug Administration (FDA) as "any substance, the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food." In other words, an additive is any substance that is added to food. Direct additives are those that are intentionally added to foods for a specific purpose. Indirect additives are those to which the food is exposed during processing, packaging, or storing. Preservatives are additives that inhibit the growth of **bacteria**, yeasts, and molds in foods.

- Additives and preservatives have been used in foods for centuries. When meats are smoked to preserve them, compounds such as butylated hydroxyanisole (BHA) and butyl gallate are formed and provide both **antioxidant** and **bacteriostatic** effects. Salt has also been used as a preservative for centuries. Salt lowers the water activity of meats and other foods and inhibits bacterial growth. Excess water in foods can enhance the growth of bacteria, yeast, and fungi. Pickling, which involves the addition of acids such as vinegar, lowers the **pH** of foods to levels that retard bacterial growth. Some herbs and spices, such as curry, cinnamon, and chili pepper, also contain antioxidants and may provide **bactericidal** effects.

Food processing-Impact On nutrition:

- The **impact** of **food processing** on the **nutritional** quality of vitamins and minerals. ...**Processing** (including preparation) makes **food** healthier, safer, tastier and more shelf-stable. While the benefits are numerous, **processing** can also be detrimental, affecting the **nutritional** quality of **foods**.

- Processing (including preparation) makes food healthier, safer, tastier and more shelf-stable. While the benefits are numerous, processing can also be detrimental, affecting the nutritional quality of foods. Blanching, for example, results in leaching losses of vitamins and minerals. Also, milling and extrusion can cause the physical removal of minerals during processing. The nutritional quality of minerals in food depends on their quantity as well as their bioavailability. The bioavailability of key minerals such as iron, zinc and calcium is known to be significantly affected by the fiber, phytic acid, and tannin content of foods. Concentrations of these constituents are altered by various processing methods including milling, fermentation, germination (sprouting), extrusion, and thermal processing. Vitamins, especially ascorbic acid, thiamin and folic acid, are highly sensitive to the same processing methods. The time and temperature of processing, product composition and storage are all factors that substantially impact the vitamin status of our foods.

Analayis of calcium in milk by complexometric method:

- • Calcium is an important component of a healthy diet and a mineral necessary for life.
- • It is a mineral that people need to build and maintain strong bones and teeth.
- • It is also very important for other physical functions, such as muscle control and blood circulation.

- • Milk is a heterogeneous mixture of proteins, sugar, fat, vitamins and minerals.
- • Milk and milk products are some of the natural sources of calcium.
- • Cow's milk has good bioavailability of calcium (about 30 to 35%).
- • Milk is an excellent source of dietary calcium for those whose bodies tolerate it because it has a high concentration of calcium and the calcium in milk is excellently absorbed.
- • It is estimated that without milk and milk products in the diet, less than half of the calcium requirements would be met.

Principle :

- In this experiment, The determination of calcium in milk is based on a complexometric titration of calcium with an aqueous solution of the disodium salt of EDTA at high pH value (12). “why?”
- • Complexometric titration is a type of titration based on complex formation between the analyte and titrant.
- • Such compounds are capable of forming chelate complexes with many cations in which the cation is bound in a ring structure.
- • The ring results from the formation of a salt-like bond between the cation and the carboxyl groups together with a coordinate bond through the lone pair of electrons of the nitrogen atom.

Indicator:

- The Solochrome dark blue indicator is a suitable indicator in this case.
- • The dye itself has a blue color.
- • This blue dye also forms a complex with the calcium ions changing colour from blue to pink/red in the process, but the dye–metal ion complex is less stable than the EDTA–metal ion complex.
- • As a result, when the calcium ion–dye complex is titrated with EDTA the Ca^{2+}ions react to form a stronger complex with the EDTA changing the dye color to blue.
- • Ca-Indicator + $EDTA^{4-}$ � $Ca\text{-}EDTA^{2-}$ + Indicator.

method :

- • Combine 10mL of sample, 40mL distilled water, and 4mL of 8M sodium hydroxide solution into an Erlenmeyer flask and allow solution to stand for about 5 minutes with occasional swirling.
- A small of magnesium hydroxide may precipitate during this time. Do not add the indicator until you have given this precipitate a chance to form.
- Then add 6 drops of the Solochrome dark blue solution.
- After that start to titrate with EDTA solution.
- Repeat titration for three trials.

SPECTROPHOTOMETRIC ANALYSIS OF IRON IN FOOD

- **Preparation of stock solution :**

Three stock solutions were made ready before the experiment and were stored in five 500 mL neatly labeled standard flasks.

- ✓ Firstly, the 0.001 M $FeCl_3$ stock solution was prepared by adding approximately 0.162 g of $FeCl_3$ in 500 mL distilled water followed by the addition of 5 mL concentrated HCl. The contents were diluted to 1 L and were mixed well before being transferred to the standard flask. This solution was only used for calibration purposes and was discarded after that.
- ✓ The 1.5 M KSCN solution was prepared by adding approximately 36.375 g of KSCN in 500 mL distilled water. The contents were mixed well before being transferred to the standard flask. This solution was the basis of the colorimetry involved in the analysis and was used till the end of the experiment.
- ✓ The 2 M HCl solution was prepared by adding 170 mL of concentrated HCl to 500 mL distilled water and diluting the solution to 1 L with distilled water. The contents were mixed well before being transferred to the standard flask. This solution was used for dilution purposes and served as the blank in the spectrophotometric analysis.

- **Apparatus and principle:** Thiocyanate spectrophotometry was carried out using a Lambda 25 UV/VIS Spectrophotometer of the PerkinElmer make. The spectrophotometer worked on the principle of the Beer-Lambert law and was operated in the visible range of the spectrum. The colorimetric reagent used for the analysis was potassium thiocyanate, for which the λmax value obtained was 480 nm.
- The basic reaction when thiocyanate reacts with iron(III) is as follows:

$Fe^{3+} (aq) + 6SCN^{-} (aq) \leftrightarrow [Fe(SCN)_6]^{3-} (aq)$

- The thiocyanate complex, $[Fe(SCN)_6]^{3-}$ had a deep red colour and its intensity was directly related to the concentration of solution. The spectrophotometric analysis was used for its simplicity, convenience and availability in the institute.

- **Calibration curve:** Seven standard solutions were prepared each having a molarity of 0.5x10-4 M, 1x10-4 M, 1.5x10-4 M, 2x10-4 M, 2.5x10-4 M, 3x10-4 M and 4x10-4 M. The first solution was prepared by diluting 0.5 mL of 0.001 M $FeCl_3$ solution with 9.5 mL of 2 M HCl solution. Similarly, the corresponding solutions are made by diluting 1 mL, 1.5 mL, 2 mL, 2.5 mL, 3 mL and 4 mL of 0.001 M $FeCl_3$ solution to 10 mL by 2 M HCl solution. After this, 5 mL of 1.5 M KSCN was added to each of the solution and mixed by swirling the test tubes. This step diluted the 10 mL solution to 15 mL causing the concentration to decrease by 2/3rd of its original molarity value. Thus, the values read by the spectrophotometer were for two-thirds of the actual concentration. After adding KSCN, the absorbance was measured immediately because absorbance value can be affected as the colour of the solution fades within 15-20 minutes. 2M HCl was used as the blank. Using these solutions, the concentration vs absorbance curve was plotted.

- **Ashing of the samples:** 1-15 g of the edible portion of the food samples was weighed. They were finely chopped for the purpose of ashing. The weighed samples were finely chopped and heated in a stainless steel vessel over a hot induction plate at 200-240°C. This step was carried out in a well ventilated room. The heating time varied depending on the amount of sample and the rate at which the sample burned to ash. The samples were heated till a grayish ash was observed and then they were powdered using a mortar and pestle. After the samples were cooled, they were transferred to a small beaker of 100 mL capacity and the iron (III) in the ash was dissolved in 10 mL-30 mL of 2 M HCl. The ash solution was stirred using a glass stirring rod for about 5 minutes and then filtered.
- **Analysis of the samples:** 5 mL of the filtered sample was transferred to a test-tube and then 5 mL of 1.5 M KSCN was added. The mixture was stirred by swirling the test tube. The absorbance was measured without delay as the colour of the solution faded within 15-20 minutes. The solution concentration was halved by adding 5 mL of KSCN, thus, the concentration values were multiplied by 2 during the calculations. The 2 M HCl solution served as the blank. The absorbance values were measured for all 25 samples.

- **Results and Discussion**: The absorbance values were determined by the spectrophotometer and the concentration was found out by interpolation or extrapolation using the calibration graph prepared earlier. After the calculations, the iron content determined in the different food samples was tabulated in an increasing order of amount of iron present as shown in Table.

S.NO	Category	Items taken in the category	Iron content (mg Fe/100 g of food sample)
1.	Vegetables	•Eggplant • Red tomato, • Spinach, • Summer squash • Cabbage	0.316 0.293 2.273 0.819 0.764
2.	Nuts	• Peanuts • Almonds (dry)	4.315 3.976
3.	Chocolates and Related items	• Dark chocolate 70% cocoa • Milk chocolate • Dates	6.514 1.355 1.414
4.	Spices and Condiments	•Green chillies • Soy Sauce • Green cardamom • Bay leaves • Cumin seeds • Black pepper	0.979 1.381 12.285 34.33 64.3 8.573

S.NO	Category	Items taken in the category	Iron content (mg Fe/100 g of food sample)
5.	Beverages	• Green tea leaves, crushed • Instant coffee powder • Drinking chocolate powder	7.271 4.704 1.219
6.	Cereals and Pulses	• Brown bread • Pasta • White rice, long grain • Kidney beans • Yellow lentils	4.067 3.432 4.417 2.019 6.008

A pie chart showing the contributions of dietary iron by the six food groups: