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A BRIEF STUDY ON LIPSTICK

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ABSTRACT

A large body of research has explored various aspects of lipstick formulation, yet no comprehensive summary of these studies has been compiled until now. This review aims to provide an overview of the history of lipsticks, the ingredients used in their formulation-focusing on both natural and synthetic components-the methods of preparation and their characterization. Relevant English-language publications were identified through searches of electronic databases such as Web of Science, Scopus, PubMed and Google Scholar. The literature consistently indicates that lipsticks have been used since ancient times and remain among the most popular cosmetic products. This review consolidates previous findings on the diverse ingredients and manufacturing techniques employed in lipstick production. Moreover, it emphasizes the growing significance of adopting eco-friendly technologies and natural ingredients in lipstick formulation to minimize adverse effects such as skin irritation and allergic reactions.

KEYWORDS

Lipsticks, Lipstick formulations, Cosmetics, Characterization of lipsticks and Methods of preparation of lipsticks.

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INTRODUCTION

Lipsticks are among the most commonly used cosmetic products, offering social, psychological and even therapeutic benefits[1]. By adding colour and providing a protective layer, lipsticks enhance a person's beauty while shielding the lips from environmental damage. Modern lip care products, however, go beyond aesthetics-they now often incorporate medicinal properties. This has led to the development of medicated lipsticks, which include active pharmaceutical ingredients that help protect against bacterial infections while maintaining

traditional moisturizing and emollient effects to prevent dryness and cracking[2].

In recent years, there has been a noticeable rise in the use of herbal ingredients in cosmeceutical and personal care formulations[3]. Herbal or natural cosmetics represent a growing trend that merges health and beauty care[4]. Consumers increasingly prefer natural over synthetic products due to their reduced side effects, absence of harsh chemicals, and additional health benefits, including nourishment for the skin[5,6].

Conversely, continuous use of synthetic lipsticks containing toxic substances such as lead, petrolatum, and phthalates can lead to lip irritation, dryness, and more serious health issues like allergies, asthma, and even cancer[7]. These risks are further heightened by habits such as lip licking or consuming food and beverages while wearing lipstick. Given the chronic and neurotoxic effects of certain chemicals-particularly lead-their presence in lip products warrants careful attention[8].

Therefore, the objective of this review is to explore comprehensive information on lipsticks, focusing on their historical background, the materials used in their formulation (both natural and synthetic), the manufacturing methods, and their physicochemical characterization[9].

A lipstick can be defined as a cosmetic product designed to impart color and texture to the lips. Typically composed of waxes, oils, pigments, and emollients, it remains one of the most popular beauty products among women for enhancing lip appearance and color[10]. In British English, lipstick is often called "lippy" Commercially, lipsticks are usually produced as moulded sticks, formulated by blending coloring pigments within a waxy or fatty base[11].

History of Lipstick

The use of colors for personal adornment dates back to around 3000 BC, when early humans used them to attract animals during hunting. The concept of "cosmeceuticals" was first introduced in 1961 by Raymond Reed, founder of the U.S. Society of Cosmetic Chemists, derived from the Greek word *kosmētikos*, meaning "decorating talent"[10,12]. Later, in 1984, Albert Kligman applied the term to describe products combining both cosmetic and therapeutic properties[13].

Throughout history, numerous herbs and plants have been utilized in cosmetics to enhance beauty and provide protection from environmental factors. Natural compounds found in these products are generally safe and may also supply nutrients and minerals beneficial to the human body[10]. Lipsticks, in particular, have been used for over 500 years[14]. Their earliest form was discovered in ancient Mesopotamia, where colored fragments resembling rough pieces of brick were used to tint the lips[15]. The practice of lip coloring is an ancient tradition that dates back to prehistoric times[16].

The first modern lipstick appeared in France in 1869, created using animal fat and beeswax[17]. In 1915, lipstick began being sold in cylindrical metal tubes, marking a significant innovation in packaging[18]. Today, lipsticks have become an essential cosmetic product, available in a wide range of colors and textures, with hundreds of shades marketed to meet increasing consumer demand[19].

Different Types of Lipstick and Their Uses

Moisturizing Lipstick

Ideal for individuals with dry lips, these contain hydrating agents such as aloe, glycerin, and vitamin E, which help maintain softness and shine, giving the lips a wet and glossy appearance[20].

Satin and Sheer Lipstick

Provide shine and nourishment while keeping lips moisturized. Due to their high oil content, they may appear darker in the package but lighter upon application, often requiring multiple coats for even color[21].

Matte Lipstick

Best suited for those seeking vibrant, bold tones. These lipsticks produce a matte, non-glossy finish that highlights the color intensity[22].

Cream Lipstick

Recommended for people with thin lips, as they offer a smooth texture without a glossy appearance, ensuring comfort and color balance[23].

Pearl and Frosted Lipstick

Create shimmery and reflective effects, making lips appear luminous by reflecting light for a glossy, eye-catching finish.

Gloss Lipstick

Favored by individuals with small or thin lips, these add shine and depth, creating an illusion of fuller lips. They can also be layered with regular lipsticks for added brilliance[24].

Long-Wearing and Transfer-Resistant Lipstick

Designed for those who prefer extended wear, maintaining lip color and appeal for up to 4.5 hours without frequent reapplication[25].

Mechanism of lipstick

The lipstick swiveling mechanism operates through a structural design that includes a cup holding the lipstick bullet and a nosepiece that both encloses and guides its movement. The cup is secured within the main body, while the nosepiece is equipped with helical guiding grooves on its inner surface. A screw, positioned inside the spiral and detachably connected to the cup, interacts with these grooves. When the spiral is rotated, the double helical projections align with and move along the grooves, causing the cup and lipstick bullet to move upward or downward, allowing smooth extension and retraction of the lipstick[26].

Ingredients of Lipstick

Lipsticks are composed of a diverse range of ingredients that may originate from natural, synthetic, or combined sources. Both synthetic-based and naturally derived ingredients are widely available in the market. However, the use of synthetic substances in lipsticks has been linked to various adverse health effects[27]. For example, lead contamination in lipstick formulations and coloring agents is a major safety concern[28]. Additionally, metals such as nickel and copper, which are often present in cosmetic products, have been reported to cause allergic reactions in sensitive individuals[29].

In contrast, herbal lipsticks are formulated using naturally sourced ingredients such as castor oil, paraffin wax, beeswax, beetroot juice, ripe fruit powder of Shukokai, lemon oil, orange essence and vanilla essence, as detailed in Table No.1 and Table No.2[30].

Wax

Both synthetic and natural waxes are key components in lipstick production. To create an even and lasting film on the lips, oils must blend effectively with these waxes[20]. The composition of the wax blend is crucial, with the best results achieved by combining waxes that have different melting points. The final melting point of the lipstick is adjusted by adding a suitable amount of a high-melting point wax to ensure proper texture and performance.

Paraffin

Paraffin wax is considered a phase change material due to its high heat storage capacity, wide availability and low cost[58]. Its production begins with slack wax, obtained through solvent dewaxing of vacuum distillates, followed by chilling and filtration using an industrial vacuum-rotary filter. After filtration, slack wax is separated from the remaining solvent, fractionated, and refined into white paraffin wax. The production of paraffin wax is therefore closely connected to lubricant manufacturing and crude oil refining processes[59].

A four-week study was conducted to evaluate the effect of paraffin wax mask packs on the skin of 20 healthy males and females. From this study, it was concluded that favorable effects on skin improvement were achieved, suggesting that paraffin wax would be of considerable utility and value in the development of skincare devices[60].

In lipsticks, paraffin wax has been utilized as a glossing, stiffening and hardening agent[17]. To produce a glossy appearance after application, liquid paraffin or white mineral oils have also been employed[20].

Two forms of paraffin wax are distinguished: macrocrystalline wax and microcrystalline wax, both of which exhibit significant physical differences. Microcrystalline wax is characterized as opaque, plastic, malleable and sticky, whereas macrocrystalline wax is described as translucent, glossy, slippery and brittle[61]. Microcrystalline wax is obtained from heavy distillates and is applied in a

variety of fields such as cosmetics, rubber compounds, candles, and metal casting, owing to its flexibility, viscosity, temperature tolerance, and adhesive properties[62]. Recent evidence has indicated that microcrystalline wax has been utilized in lipstick production as a base and stiffening agent[63].

Ozokerite wax

Ozokerite wax is manufactured from coal and shale[64]. It is employed to raise the melting point of the stick[20]. However, lipsticks containing more than 10% ozokerite have been observed to crumble during application[20].

Ceresin wax

Ceresin wax, also referred to as mineral wax, is defined as a type of ozokerite refined through the use of sulfuric acid. At present, the term *ceresin wax* is used generically for commercial products in which pure ozokerite is combined with other solid hydrocarbons to produce waxes of varying melting points. Its function is regarded as comparable to that of ozokerite, as it is employed to raise the melting point of cosmetic products[20-23].

Butyl stearate

Butyl stearate is employed with castor oil as a partial solvent due to its wetting qualities, which enable the fine dispersion of undissolved dyestuff[20,37].

Castor oil

Castor oil is substituted with oleyl alcohol, which serves as a superior eosin solvent and facilitates the preparation of high-staining sticks. When the wax composition is adjusted to achieve a higher melting point, sticks based on oleyl alcohol are distributed smoothly and evenly, though they leave behind an oily film. To prevent rancidity, an antioxidant is incorporated into formulations containing oleyl alcohol[24].

Oleyl alcohol

Cases of lipstick dermatitis attributed to oleyl alcohol were first documented in 1960, and sporadic reports of allergic reactions have since been recorded, primarily in cosmetic products. Because routine testing is not carried out, oleyl alcohol may be a more frequent allergen than evaluated 146 individuals with suspected allergies to topical treatments containing five fatty alcohols and observed 34 positive responses, 33 of which were caused by oleyl alcohol (30%) in petrolatum, while all controls tested with 10% petrolatum were negative[66].

Preservatives

The safety of natural preservatives has been increasingly highlighted in comparison with synthetic alternatives[67-70]. High antimicrobial efficacy has been suggested to extend the shelf life of formulations[70]. Conversely, synthetic preservatives pose a higher risk of skin reactions[70]. Parabens (PHB), the most commonly used synthetic preservatives in cosmetic products, have been associated with hypersensitivity reactions such as contact dermatitis[71]. Their weak estrogen-like activity has raised concerns regarding a potential link to breast cancer and they are frequently reported to cause skin irritation and allergic responses[70]. Lipsticks have been identified as containing the highest concentrations of parabens among cosmetic products[72]. For example, methylparaben and other parabens are widely used in cosmetics as well as in oral and topical pharmaceutical formulations. Additionally, lipsticks may contain 0.1% propyl-p-hydroxybenzoate as a preservative, although concentrations of 0.2% have been reported to cause mild burning sensations and, in rare cases, eosin-mediated allergic reactions in sensitive skin[20].

Vitamin E

Vitamin E, first discovered by Evans and Bishop in 1922 as an essential dietary component for reproduction in rats[73], is available in both natural and synthetic (α-tocopherol) forms[74]. Although no detailed comparative investigations on the use of natural versus synthetic vitamin E in lipsticks have been conducted, it has been widely incorporated into lipstick formulations as an antioxidant[27,28].

Lanolin

Lanolin is commonly utilised in cosmetics and topical products for its emollient properties. Anhydrous lanolin (wool fat) is often blended into lipsticks in amounts ranging from 2% to 20%[75]. Higher concentrations of lanolin impart specific

emollient effects and result in a thick, unctuous film, though they may also produce oily or sticky textures and strong odours, particularly during storage[76]. Lipstick formulations typically involve blending fatty substances such as lanolin or its derivatives, which act as plasticizing agents[77]. These materials enhance the durability and thickness of the film, improve spreadability, and prevent phase separation of liquid and solid ingredients, which could otherwise result in sweating or blooming of the final produc[t78]. Despite these benefits, prolonged or repeated use of lanolin has been associated with contact allergies in 1.2% to 6.9% of patients with dermatitis[79].

Titanium dioxide

Titanium dioxide is incorporated into lipsticks as a pigment and to modify the shade of base colours. Its high brightness contributes significant covering power, making it preferable over zinc oxide in lipsticks and other cosmetic products[20,21,31].

Colouring elements

The primary colouring elements, as opposed to the staining materials, are represented by insoluble dyestuffs and lake colours such as calcium, barium, and aluminium lakes. Depending on the tint and opacity of the film, an amount between 10% and 15% is utilised in a lipstick[18,20]. To guarantee a smooth application, a fine and consistent particle size is required for the colours. Appropriate colouring and covering strength, as well as good opacity, are expected. The behaviour of the colours with oil is also considered important since the ultimate uniformity of the mass is influenced by it[20]. A similarly effective gloss is produced by two or three percent isopropyl myristate or isopropyl palmitate and at this concentration, no effect is observed on the durability of the film[20]. However, the presence of lead in lipsticks and colouring chemicals is regarded as one of the primary concerns[9].

Acetoglycerides

Acetoglycerides are regarded as blending agents by which the rheological properties of oils, fats, and waxes in lipstick formulations are altered. Plasticity properties are imparted to the stick formulations, allowing solidity to be maintained in hot weather while spreadability qualities are preserved at low temperatures[20,35]. For formulation purposes, they are divided into two categories: liquid and solid. The behaviour is explained by the fact that the liquid acetoglycerides are considered to exert a plasticizing effect on the oily ingredients, whereas the solid acetoglycerides are regarded as having a comparable impact on the waxes. As a consequence, a better outcome is obtained by a mixture of two parts solid acetoglyceride and one part liquid acetoglyceride, rather than by utilising them separately[18,20,36.]

Bromo Mixture

The phrase *"bromo mixture"* is referred to as the component of the product by which an indelible stain is left, in contrast to the opaque film of colour that is produced by insoluble pigments. A solution consisting of dyestuff (also known as bromo acids) for staining in combination with appropriate ingredients is described as the bromo mixture[24]. Examples of the dyestuffs include fluorescein, halogenated fluorescein, and related water-insoluble dyes[24]. Bromo acids available in D and C colours are divided into two groups: red bromo acids, by which a red or reddish-blue stain is produced, and orange-red bromo acids, by which a pink to yellowish-pink stain is produced[80]. Even when the undissolved dyestuff is finely disseminated, suspension in the oil/wax film is maintained if castor oil is employed as the sole solvent in the formula. Mild abrasive impact and the potential for allergic consequences may be produced by the undissolved dyestuffs if they are not detected and are present in the finished product[24,37]. Solvents of bromo acids such as tetrahydrofuryl alcohol and esters such as acetate, stearate, and benzoate are considered effective, although certain esters, particularly acetate, are noted to possess penetrating odours that must be masked with appropriate scents[20]. The achievement of a suitable solvency lipstick base for bromo has always been regarded as a challenge[24]. Consequently, solvents of this nature are associated with skin dryness and the induction of dermatitis; however, as they are capable of

dissolving up to 25% of bromo acids, only small amounts are required to achieve favourable staining results. In such cases, an increased quantity of emollient is recommended to counteract the drying effects[24].

Ripe fruit powder of *Shikakai*

Ripe fruit powder of *Shikakai*, a medicinal plant, is utilized as a surfactant in the formulation of lipsticks through the use of its fruits[81]. The findings of McClements *et al*, (2017) were reported to be consistent with Schreiner *et al*, (2020), by which it was noted that the use of natural surfactants is encouraged for the production of environmentally friendly formulations, in line with the lower toxicity associated with such compounds[82]. Lemon oil is described as a colourless or yellow liquid with a strong lemon scent and citrus aroma[83]. Its incorporation in lipstick formulations is regarded as essential, since antioxidant, anti-aging, and antimicrobial properties effective against bacterial and fungal infections are exhibited by the oil[84]. The importance of flavouring agents has been emphasized in their role of masking the taste of lipstick ingredients. It was highlighted by Kadu *et al*, (2015) and Sharma (2018) that flavouring agents are essential for masking the odour of the fatty or wax base while imparting an attractive flavour[85]. Strawberry essence was reported to have been used by Sainath et al. (2016), Bhagwat *et al*, (2017), and Rasheed *et al*, (2020), whereas orange essence was reported to have been used by Sunil et al. (2013)[86].

Natural Preservatives

Natural preservatives have been documented to be employed in the preparation of lipsticks, including tea tree, lemongrass, rosemary, lavender, and ginger powder[87]. As an alternative to parabens, ginger (*Zingiber officinale*) has been widely tested for antimicrobial activity[88]. It is recognized as a common plant of the Zingiberaceae family, widely cultivated in the central, southeastern and southwestern regions of China, as well as throughout tropical Asia[89]. In much of the current literature on ginger, particular attention has been paid to the isolation and pharmacological analysis of a variety of bioactive compounds such as tannins, flavonoids, glycosides, essential oils, furostanol, spirostanol, saponins, phytosterols, amides and alkaloids from different parts of the plant[90].

Curcuma longa

Curcuma longa (turmeric) has been utilised as a spice in food and as a medicinal plant for a variety of ailments, including inflammation, pain, wound healing and digestive issues. The impact of turmeric and its bioactive curcuminoid polyphenols on a range of chronic diseases has been demonstrated in preclinical studies[91]. A spectrum of antimicrobial activity has been reported for different fractions of turmeric against *Staphylococcus aureus*, suggesting that turmeric can be employed for the management of microbial infections[92]. Additionally, turmeric powder has been used in the formulation of lipsticks as an antimicrobial agent[93] and has also been suggested as a natural colouring agent in lipstick manufacturing[94].

The red colouring agent in lipstick preparations has been provided by *Hylocereus polyrhizus*, a member of the Cactaceae family, also known as dragon fruit[95]. Its potential antimicrobial activity has been demonstrated in natural lipstick formulations when tested against the growth of Escherichia coli, Klebsiella pneumoniae, Salmonella typhimurium, Staphylococcus aureus, and Enterococcus faecalis[96].

Vanilla essence

Vanilla essence has been utilised as a preservative in lipstick formulations[50]. It can be extracted from the vanilla pod of *Vanilla planifolia*, a perennial hanging plant belonging to the Orchidaceae family, native to tropical rainforests in Mexico, Madagascar, Tahiti, Indonesia, Seychelles, and the Philippines[97]. Numerous health benefits have been attributed to vanilla, including antioxidant, antineoplastic, and cholesterol-lowering effects, anti-sickling activity, and antimicrobial activity against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus cereus*, *Escherichia coli* and *Yersinia enterocolitica*[98]. Its ability to suppress peroxynitrite-mediated processes, significant in neurodegenerative diseases such as Alzheimer's and Parkinson's, has also been reported[99]. The majority of studies on the use of vanilla essence in lipstick

formulations have been quantitative, and no study has specifically investigated its preservation effects in lipsticks[100].

Olive Oil

Olive oil, obtained from the fruit of the olive tree (*Olea europaea*), has been used as a blending agent in lipstick formulations[101]. The active ingredients in olive oil, including oleic acid, phenolic compounds, and squalene, have been shown to possess antioxidant properties[102]. Phenolics, such as hydroxytyrosol, tyrosol and oleuropein, have been associated with the reduction of coronary heart disease and hypertension incidence, a lower risk of certain cancers including breast, skin, and colon cancer, and the provision of antimicrobial and anti-inflammatory activities[103]. Olive oil has also been utilised as a base in the preparation of water-in-olive oil (W/O) types of lipsticks. Its antioxidant action, particularly that of oleuropein, has been reported to act against free radicals at the skin level[104]. Conversely, topical treatment with olive oil has been indicated to negatively affect skin barrier function and potentially exacerbate pre-existing atopic dermatitis[105].

Castor oil

Castor oil, derived from the seeds of *Ricinus communis*, has been widely used as a lipstick base due to its colourless to pale yellow appearance, high viscosity, and compatibility with other ingredients[105].

Beeswax

Beeswax, a natural wax obtained from honeybees of the genus *Apis*, is recognised as a mandatory ingredient in lipstick formulations. It is used as a glazing agent to provide a glossy appearance and to harden the texture of the lipstick[105]. Moisture retention for dry and chapped lips is also facilitated by beeswax[106]. Various studies have reported that small amounts of natural antibacterial agents are contained in beeswax, which may help prevent painful inflammation associated with infections[107]. However, slight differences in the quantities of beeswax and castor oil have been observed between studies. In the study by Aher *et al*, (2012), 15grams of beeswax and 36grams of castor oil were used, while Sunil *et al*, (2013) employed 36grams of beeswax and 16grams of castor oil[108]. Stable lipstick formulations were reported in both studies[109]. Nevertheless, no research article has focused specifically on the significance of the beeswax-to-castor oil ratio in formulation.

Carnauba Wax

Different types of wax have been used as hardening agents in lipstick formulations. Carnauba wax has been utilised by Patil *et al*, (2019), Bhagwat *et al*, (2017), Maru and Lahoti (2018), and Ghongade *et al*, (2021), while candelilla wax has been employed by Lwin *et al*, (2020). Paraffin wax has been used by Sunil *et al*, (2013) and Chaudhari *et al*, (2019). These waxes are categorised as hardening agents, responsible for imparting the desired hardness to lipsticks[108]. The differences among these waxes are reflected in their melting points: carnauba wax ranges from 80 to 88°C[17]; candelilla wax ranges from 61 to 89°C[21] and paraffin wax is commercially available in various grades with different specified melting ranges[110].

Carnauba wax, obtained from the leaves of the carnauba palm (*Copernicia prunifera*) which grows exclusively in the arid northeast Caatinga region of Brazil, is a hard wax with a high melting point and low solubility[109]. The natural leaves of the carnauba palm are coated with a waxy material, which serves as the raw material for wax production[111]. Due to its high melting point, carnauba wax has been suggested as a suitable base and moisturizer for lipstick formulations[55,56]. Candelilla wax is produced from the leaves and stems of candelilla bushes (typically *Euphorbia cerifera*, syn. *Euphorbia antisyphilitica*), which grow wild in northern Mexico and southern Texas[112]. The wax is obtained either by boiling the plant material or extracting it with benzene, and is commercially available in yellow to brown hues[113]. It has been incorporated in food, cosmetic, and personal care products, particularly in lipsticks[114]. Alkenones wax, an off-white waxy solid obtained from *Isochrysis sp.*, has been suggested as a promising base for lipsticks and other personal care products[21].

Coconut Oil

Coconut oil, derived from the dried kernel (copra) of the coconut palm (*Cocos nucifera*), ranges in colour from white to light brownish yellow and contains a high concentration of low molecular weight saturated fatty acids, distinguishing lauric oil from other oils[111,112]. The inclusion of coconut oil in lip preparations has been reported to soften and moisturize lips while promoting a healthier appearance[113,114].

Pitaya

Hylocereus polyrhizus (pitaya), a member of the Cactaceae family, is commonly known in Asia as dragon fruit[55]. The pulpy exocarp or soft fleshy mesocarp/endocarp, which contains the seeds, exhibits a red hue[56]. Pitaya has been associated with multiple health benefits, including cancer prevention, anti-inflammatory and anti-diabetic properties and a reduction in cardiovascular mortality risk[57]. Due to its high content of linoleic and linolenic acids (unsaturated fatty acids), pitaya seed oil is commonly included in natural lipstick formulations[58]. Unsaturated fatty acids have been reported to regulate oil flow through the skin and improve metabolic processes within the skin[59].

Mangosteen rind

Mangosteen rind (*Garcinia mangostana* L.), often considered a waste product, contains various water-soluble antioxidants. Alpha-mangostin and other xanthones present in the rind have been reported to exhibit significant antioxidant activity[115].

Method of Preparation

The production of lipsticks is reported to vary slightly depending on the type of ingredients used. The moulding method has been suggested as a standard procedure for lipstick preparation (Figure No.1). According to McIntosh *et al*, (2018), the ingredients used in lipstick preparation were categorised into three phases: phase A, phase B and phase C[21]. Phase A consisted of waxes, phase B included dyestuff and oils, while phase C comprised preservatives and other additives[21].

In the study by McIntosh *et al*, (2018), phase A was heated to 80°C, after which phase B ingredients were added one by one to phase A. Following the removal of the combined phases A and B from heat, phase C ingredients were incorporated, and the mixture was then poured into lipstick moulds[21]. On a different occasion, the same method was adopted by Esposito *et al*, (2021) in the preparation of organ gel-based lipsticks[116]. However, in that case, phase A was heated to 200°C, while phase B was heated separately to 100°C, with the pigment dispersed thoroughly in phase B before its addition to phase A[116].

In general, the wax phase (phase A) is prepared by melting the waxes in a water bath in decreasing order of their melting points. The temperature selected depends on the melting points of the waxes, with the water bath temperature determined by the highest melting point of the wax constituent used in the formulation[1,6,13,14,29,55].

Characterization / Evalution

A standardised criterion for herbal lipsticks is considered essential. Hence, the formulated lipsticks were evaluated on parameters such as melting point, breaking point, thixotropy character, force of application, surface anomalies, aging stability, solubility, pH, skin irritation, perfume stability, and lead limit tests[14,29,48,50,51]. Furthermore, the manufacturing of lipsticks was regulated by the Food and Drug Administration (FDA) based on the detection limits of lead and colour additives[117].

Melting Point

The melting point was determined to indicate the limits of safe storage[6,14]. The capillary tube method using a digital melting point apparatus was employed to measure the melting point of the formulated lipsticks[14]. The lipstick sample was filled into a capillary tube and the temperature at which complete melting occurred was recorded[14]. Similar methods were applied in other studies[6,38,49,50,86,105].

In detailed studies by Azwanida *et al*, (2014) and Bhagwat *et al*, (2017), the ingredients were melted and poured into 50mg glass capillary tubes opened at both ends[49], cooled for 2 h in ice and the melting point was recorded using a thermometer[6,49]. In the method by Azwanida *et al*, (2014), a digital thermometer was immersed in a beaker containing

water placed on a hot plate stirrer, and heating and stirring were initiated slowly at a fixed speed[49]. The melting point was noted when the lipstick sample moved along the capillary tube[6,49]. A digital melting point apparatus was also used in other studies, where 2 g of lipstick sample was placed into a glass tube, immersed in a water bath, heated, and the melting point recorded[107]. The melting point of lipsticks ranged from 59 to 64°C[6,14,38,107].

Softening Point

The softening point was determined to assess the ability of lipsticks to withstand conditions encountered in consumer use[6,118]. The ring and ball method was applied by inserting the lipstick into a ring, cooling it in a refrigerator at 6°C for 10 min, and immersing the assembly in a water bath[6,119]. The temperature was increased at a rate of 1°C per minute after reaching 45°C[118] and the softening point was observed when the ball passed through the lipstick sample[119]. The softening point was reported as 68°C[6], with a target range of 68-74°C[119]. A higher softening point was considered indicative of better lipstick stability[119].

Breaking Point

The breaking point test was conducted to determine lipstick hardness, an important physical property[48]. The lipstick was placed horizontally in a socket 12 inches away from a support edge and a fixed weight of 10g was progressively applied at 30 s intervals until the lipstick broke[48]. This method was used in multiple studies[29,38,50,86,105] and breaking points ranged from 30 to 32[29,38,50,86,105]. A texture analyser was also employed and the distance travelled by the hemispherical edge blade under a trigger force of 10g was recorded. Higher breaking point values were considered indicative of better texture[120].

Thixotropy Character

The thixotropy test was conducted to evaluate the uniformity of viscosity in the lipstick base[48]. A penetrometer was used, and the depth of penetration of a needle under a 50g load at 25°C for 5 s was measured to assess thixotropic properties[48]. This method was applied in several studies[14,38,50,53], with thixotropy values ranging from 9 to 10.5[14,38,48,50,53]. No comparative guidelines for this test were identified.

Force of Application

The force required for lipstick application was measured using a shadow graph balance[50]. A coarse brown paper was placed on the balance and the lipstick was applied at a 45° angle to cover 1 square inch. The force was recorded via a pressure reading[50], as described in multiple studies[86]. No standard guidelines for this test were identified.

Surface Anomalies

Surface anomalies were visually inspected to ensure product quality and conformity with standards[14,29,51,86,121]. The evaluation included marks, heterogeneity, pollution and distortion[124]. Absence of defects such as crystal formation or microbial contamination indicated acceptable quality[12,29,51,121].

Stability upon Storage

Stability upon storage was evaluated to determine shelf-life and packaging requirements[29]. Organoleptic characteristics, including colour, odour, pH, bleeding and crystallization, were assessed[6,29,122]. Lipsticks were stored at room temperature (24.0±3.0°C) for 48 h to establish baseline properties[49] and then at refrigerator (4°C), room (24.0±3.0°C), and high temperature (40.0±2.0°C) conditions for various durations[6,29,49]. Accelerated stability studies were performed according to ICH guidelines at 40°C/75% relative humidity[123].

Spreadability Test

Spreadability was determined by applying lipstick over a surface of 3cm on paper or a glass slide and visually inspecting the smoothness and uniformity of the layer[124,125]. Ratings included Excellent (E), Intermediate (I), and Unsatisfactory (U) based on fragment presence and uniformity[124,125].

Solubility Test

Solubility tests were performed to evaluate the polarity of lipstick compounds[126-1128]. A few drops of lipstick were added to solvents such as methanol, ethanol, chloroform, and petroleum ether and solubility was observed[14,38,50,51,86,105]. Lipstick containing castor oil was found soluble in alcohol

and had limited solubility in petroleum solvents[18,129].

pH Parameter

The pH of formulated lipsticks was measured using a potentiometric method[14,86,130,131]. The lipstick was melted in a water bath and pH was recorded[140]. Safe pH values for lipsticks were reported to range from 4 to 7[14,86,131,132], with reviewed studies showing values between 4 and 6.5[6,14,38,86,107].

Skin Irritation Test

Skin irritation was evaluated using human models or animal models[50,86,1]. In human studies, lipsticks were applied to the lips and symptoms such as itching, redness, or irritation were observed for 10 min[50,86]. In animal studies, mice were anaesthetized and approximately 10mg of lipstick applied to the dorsal region of the left ear and observations were compared with controls[1].

Cosmetic animal testing is not recommended or is banned in some countries[133-135].

Lead and Other Metals Limit Test

The determination of lead and other metals in lipsticks was conducted using flame atomic absorption spectrophotometry[9] or novel methods such as microwave-assisted dispersive liquid–liquid microextraction (MADLLME) with graphite furnace atomic absorption spectrometry (GFAAS)[136]. The FDA has developed and validated methods to quantify lead content in lipsticks to protect public health[117].

Table No.1: Synthetic ingredients with their quantities in the formulation of lipsticks

S.No	Ingredients	Functions	Quantity % (w/w)	Reference
1	Paraffin wax	Glossy, hardness, stiffening agent	28	31
2	Butyl stearate	Lipstick base and solvent for dyestuff and dispersing agent	1-25	32
3	Microcrystalline wax	Lipstick base	2	33
4	Ozokerite wax	Lipstick base	3-10	34
5	Ceresin wax	Lipstick base	3-10	35
6	Oleyl alcohol	Blending agent, emollient, oleaginous vehicle, solvent	40-50	36
7	Methyl paraben	Preservative	0.1-1	37
8	Propyl paraben	Preservative	0.1-1	38
9	Propyl-p-hydroxybenzoate	Preservative	0.1-0.2	39
10	Vitamin E	Antioxidant	0.5	40
11	Lanolin alcohol	Blending agents and plasticizing effect	2-5	41
12	Anhydrous lanolin	Blending agent	2-20	42
13	Anhydrous lanolin	Pigment, brightener	1-40	43
14	Zinc oxide	Pigment, brightener	1-40	44
15	Calcium, barium and aluminium lakes	Colouring agents	10-15	45
16	Isopropyl myristate or isopropyl palmitate	Colouring agents	2-3	46
17	Acetoglycerides	Blending agents and plasticiser	2.5-7	47
18	Bromo mixture	Colouring agents	2-25	48

Table No.2: Natural ingredients with their quantities in the formulation of lipsticks

S.No	Ingredients	Functions	Quantity	Reference
1	Ripe fruit powder of Shikakai	Surfactant	12	49
2	Lemon oil	Antioxidant, preservative, flavouring agent	0.1-1	50
3	Orange essence	flavouring agent	1.5	51
4	Mango butter for Mangifera indica	Lipstick base	10	52
5	Beetroot juice	Colouring agent	6	53
6	Theobroma cocoa	Colouring agent	40	54
7	Lycopene	Colouring agent	2.5	55
8	Punica granatum from pomegranate	Colouring agent	5-9	56
9	Amaranthus Cruentus L	Colouring agent	0.5-1	57
10	Jati leaves	Colouring agent	18-22	58
11	Ginger powder	Antimicrobial agent	2	59
12	Turmeric Powder	Antimicrobial agent	5-6	60
13	Hylocereus polyrhizus	Antimicrobial agent	4-10	61
14	Vanilla essence	Preservative	10	62
15	Olive oil	Lipstick base	10-30	63
16	Castor oil	Blending agent	40-50	64
17	Meadowfoam seed oil	Blending agent	5	65
18	Beeswax	Blending agent	3-10	66
19	Candelilla wax	Lipstick base and moisturizer	1-10	67
20	Carnauba wax	Lipstick base and moisturizer	1-5	68
21	Alkenones wax	Lipstick base and moisturizer	2-5	69
22	Coconut oil	Lipstick base and moisturizer	25-45	70
23	Pitaya seed oil	Lipstick base and moisturizer	10-45	71
24	Mangosteen rind	Antioxidant	4-8	72

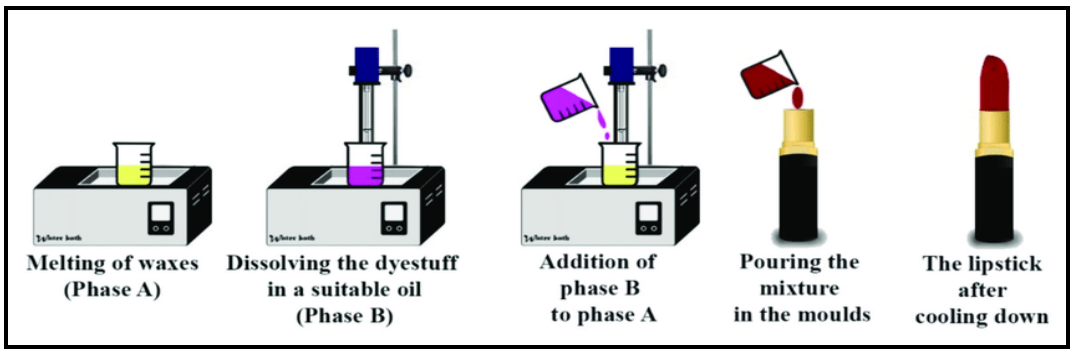

Figure No.1: Process of formation of lipstick

CONCLUSION

On lipstick formulation and evaluation asserts that lipsticks, utilizing natural ingredients, are safer and offer potential therapeutic benefits compared to traditional synthetic formulations, successfully meeting ideal characteristics such as smooth application, stability, color retention and safety. The research confirms that natural ingredients can create stable, effective, and appealing lipsticks with minimal side effects, though further clinical trials are recommended for commercial application.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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