Formulation, Evaluation and Comparative studies of Herbal Anti-acne Sunscreen Foundation Stick

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Abstract -
Background: The growing demand for multifunctional herbal cosmetics has accelerated the development of formulations that provide both therapeutic and aesthetic benefits. Herbal ingredients such as tea tree oil and green tea extract are well known for their antimicrobial and antioxidant properties, making them suitable for dermatological and cosmetic applications.
Objective: The objective of the present study was to formulate and evaluate an herbal anti-acne and antioxidant foundation stick using tea tree oil and green tea extract, and to assess its physicochemical properties, safety, and effectiveness.
Methods: The foundation stick was formulated using a combination of waxes, oils, pigments, and herbal actives. The prepared formulation was evaluated for various parameters including organoleptic properties, pH determination, melting point, spreadability, adhesion, skin irritation test, antimicrobial activity, and stability studies using standard procedures.
Results: The optimized formulation exhibited desirable organoleptic characteristics such as smooth texture, uniform consistency, and pleasant odour. The pH of the formulation was found to be 6.8, indicating good skin compatibility. The melting point was observed at 54.3°C, suggesting acceptable thermal stability. The formulation showed good spreadability (34 g·cm/sec) and adhesion properties. Antimicrobial studies demonstrated a zone of inhibition of 1.2 cm against acne-causing microorganisms, confirming its anti-acne activity. No skin irritation or surface anomalies were observed, indicating safety and stability of the product.
Conclusion: The formulated herbal foundation stick showed satisfactory physicochemical properties, effective antimicrobial activity, and good stability. It can be considered a safe and effective cosmetic formulation that provides both therapeutic (anti-acne and antioxidant) and aesthetic benefits, making it a suitable alternative to conventional foundation products.

Keywords: **Herbal foundation stick, Tea tree oil, green tea extract, Anti-acne, Antioxidant, Cosmetic formulation.**

I. INTRODUCTION

As per D and C Act cosmetics are defined as any article that is intended to be rubbed, poured, sprinkled or sprayed on or introduce into or otherwise applied to human body or any other part thereof for cleansing, beatifying, promoting attractiveness or altering the appearance, which includes any article intended for use as cosmetic (given in section 3) of D and C act 1940 and rules1945.[1]

FOUNDATION STICK:
a) Definition:
A foundation stick is a solid cosmetic formulation designed in a stick form that provides coverage to the skin for an even complexion. It is composed mainly of waxes, oils, pigments, and emollients, which give it a semi-solid texture suitable for direct application on the face. Foundation sticks are preferred for their portability, ease of use, and ability to deliver medium to full coverage with good adherence to the skin.[2,3,4]

Properties of foundation stick:[5]
Foundation sticks possess specific physicochemical and application properties that make them suitable for cosmetic use:

- Semi-solid consistency due to balanced wax–oil composition
- Smooth texture for easy application on skin
- Good spreadability and blendability
- Adequate hardness to maintain stick shape
- High pigment dispersion for uniform coverage
- Good skin adherence and film-forming ability

Applications for Foundation Stick:
1.Even Skin Tone Correction: Foundation sticks are widely used to provide uniform skin tone by masking discoloration, redness, and uneven pigmentation, resulting in a smooth and flawless appearance.[6]

2.Coverage of Blemishes and Imperfections: They effectively conceal acne, scars, dark spots, and minor skin defects due to their high pigment concentration and good adherence properties.[7]
3.Base Makeup for Professional and Daily Use: Foundation sticks act as a base layer in makeup routines, creating a smooth canvas for further cosmetic products like blush, powder, and contour.[8]
4.Contouring and Highlighting: Due to their solid form and precise application.[9]

Key Benefits of Foundation Stick:

Fig.1. Benefits of foundation stick

II. MATERIALS AND METHODS USED

All the required raw materials were procured from local market, Nagpur. Method For Preparation of Herbal Foundation stick:[9,10,11] The steps used to prepare the Herbal Foundation stick method are as follows

1.Pigment Phase (Dispersion Phase):
In this phase, all the colouring agents such as titanium dioxide (for opacity and coverage) and iron oxides (for skin tone shades) are accurately weighed. These pigments are then mixed with a small quantity of a suitable oil, usually castor oil.The mixture is ground using a mortar and pestle or mechanical grinder until a smooth, homogeneous, lump-free paste is obtained.This step ensures uniform colour distribution, better spreadability, and improved appearance of the foundation stick.

Fig 1. Dispersion Phase

2. Oil Phase (Base Formation Phase):
In this phase, all the waxes and oils are combined to form the base of the stick. Commonly used waxes include beeswax, carnauba wax, and paraffin wax.These ingredients are placed in a clean beaker and heated on a water bath at a temperature of about 70–80°C. Heating is continued until all the waxes are completely melted and a clear, uniform liquid mixture is obtained. Continuous stirring is required to ensure uniform melting and to prevent overheating or degradation of ingredients.
3. Incorporation of Pigment Phase into Oil Phase:
Once the oil phase is completely melted, the prepared pigment dispersion is slowly added into the molten base with continuous stirring. This step must be carried out carefully to ensure that the pigments are evenly distributed throughout the formulation. Proper mixing prevents colour streaking and ensures consistent shade and texture.
4. Water Phase and Emulsification
Generally, foundation sticks are anhydrous systems and do not contain water. However, in some modified formulations, a small water phase containing humectants like glycerin may be included. In such cases, an appropriate emulsifier is required to mix the water and oil phases. Both phases are heated separately to the same temperature (around 70°C) and then combined with continuous stirring to form a stable emulsion. However, this type of formulation is less common for sticks and more typical of cream or liquid foundations.
5. Addition of Additives (Cooling Phase):
After uniform mixing, the temperature of the formulation is reduced to around 60°C. At this stage, heat-sensitive ingredients are added, such as: Vitamin E (antioxidant)
7.Moulding (Filling Phase):
The final molten mixture is then carefully poured into pre-cleaned and dry stick moulds. Pouring should be done slowly and steadily to avoid the formation of air bubbles, which can affect the appearance and structure of the stick.

Fig. 2. Demoulding

7.Cooling and Solidification Phase: The filled moulds are allowed to cool at room temperature. As

the temperature decreases, the waxes begin to crystallize and solidify, giving the formulation its final rigid structure and stick form. Proper cooling is important to avoid cracks or surface defects.

8. Finishing and Packaging: After complete solidification, the sticks are removed from the moulds. The surface may be smoothed or polished. Finally, the finished sticks are packed in suitable containers such as twist-up tubes for use and storage.

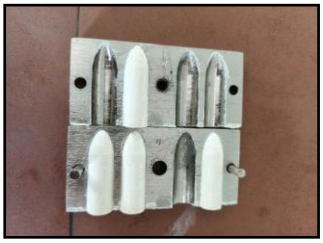

Fig.3. Finishing of stick

Role of Herbal Ingredients:

Table.1. Role of Herbs

Sr. No	Ingredients	Importance of Ingredients
1.	Beeswax	Provides hardness and structure; helps stick keep its shape
2.	Carnauba wax	Increases melting point; gives glossy and firm texture
6.	Castor oil	Helps in pigment dispersion; gives shine and moisturization
11.	Green tea extract	Acts as antioxidant; protects skin from damage
12.	Tea tree oil	Provides antimicrobial and anti-acne effect
13.	Vitamin oil	Acts as antioxidant; prevents oxidation and nourishes skin

Formulation table:

Table.2. Formulation table

Sr.no	Ingredients	Quantity Taken (g)
1.	Beeswax	12
2.	Carnauba wax	3
3.	Stearic acid	5
4.	Cetyl alcohol	4
5.	Liquid Paraffin	34
6.	Castor oil	14
7.	Titanium dioxide	8
8.	Brown iron oxide	8
9.	Zinc oxide	3
10.	Green tea extract	1
11.	Tea tree oil	1
12.	Vitamin E	0.5
13.	Isopropyl myristate	2

Fig.4.Formulated Foundation stick

A. BEESWAX:[12,13]

The ingredients used in the formulation of foundation stick:

Fig.5. Beeswax

Table .3. Information of Beeswax

Common name	Beeswax
Synonym	Paraffin wax, Carnauba wax
Biological Source	It is obtained from the honeycomb of the honeybee *Apis mellifera*.
Family	Apidae
Chemical constituents	Carbon (73.3%), Hydrogen (13.2%), Oxygen (7.5%)

Uses	• moisturizer • prevents dryness and cracks

B. CARNUBA WAX: [14,15]

Fig. 6. Carnauba wax

C. CASTOR OIL:[16,17]

Table.4. Information of Carnauba wax

Common name	Carnauba wax
Synonym	Brazil wax, palm wax
Biological source	Carnauba wax is obtained from the dried leaves of the *Copernicia prunifera*.
Family	Arecaceae
Chemical constituents	Aliphatic esters (80-85%), Fatty alcohols, Hydrocarbons, Cinnamic acid derivatives, Resins.
Uses	Acts as a thickener and binder.

Fig.7. Castor oil

Table 5. Information of Castor oil

Common name	Castor oil
Synonym	Ricinus oil,
Biological Source	Castor oil is the fixed vegetable oil obtained by cold expression of seeds of the *Ricinus communis.*
Family	Euphorbiaceae
Chemical Constituents	Ricinoleic acid (85-90%), Oleic acid, linoleic acid, stearic acid, palmitic acid
Uses	Act as emollient
	Act as Plasticizer and binder

D. TEA TREE OIL:[18,19]

Fig .8. Tea tree oil

Table.6. Information of Tea tree oil

Common name	Tea tree oil
Synonym	Melaleuca oil, Ti-tree oil
Biological Source	Tea tree oil is volatile essential oil obtained by steam distillation of fresh leaves and terminal branches of *Melaleuca alternifolia.*
Family	Myrtaceae
Chemical Constituents	Terpinen-4-ol (30-40%), γ-Terpinene α-Terpinene, 1,8-Cineole, α-Terpineol
Uses	• Used in acne treatment products and face cleansers. • Acts as a natural preservative and antimicrobial agent.

E. GREEN TEA EXTRACT:[20,21]

Fig 9. Green tea extract

Table. 7. Information of Green Tree Extract

Common name	Green tea
Synonym	Camellia extract, Tea polyphenols
Biological Source	Green tea extract is obtained from the dried leaves of *Camellia sinensis.*
Family	Theaceae
Chemical Constituents	Polyphenols (Catechins ~30–40%), Epigallocatechin gallate (EGCG – major active),

	Epicatechin (EC), Epigallocatechin (EGC), Caffeine, Tannins, Flavonoids
Uses	• Added in anti-aging and sunscreen formulations.

F. VITAMIN E: [22]

Fig 10. Vitamin E

Table.8. Information of Vitamin E

Common Name	Vitamin E
Synonym	Tocopherol, Alpha Tocopherol
Biological Source	Vitamin E is a fat-soluble vitamin obtained from vegetable oils such as sunflower oil, wheat germ oil and soyabean oil.
Family	Tocopherols
Chemical Constituents	α-Tocopherol (most active form), β-, `γ-, δ-Tocopherols, Tocotrienols
Uses	• Acts as an antioxidant preservative → prevents rancidity of oils/waxes

III. EVALUATION

Evaluation of Formulated Foundation stick:[23]

Organoleptic Characteristics:

The Physical evaluation of preparation performed include organoleptic evaluation and homogeneity of preparation.

Table.9. Organoleptic properties

Sr.no.	Properties	Observations (Formulated)
1.	Physical appearance	Smooth, uniform, opaque, no cracks
2.	Colour	Skin tone shade, light beige
3.	Odour	Pleasant, Characteristics
4.	Homogeneity	Homogenous

Texture and Consistency:

Table.10. Texture and Consistency

Sr.no	Properties	Observations
1.	Texture	Smooth
2.	Consistency	Thick

Determination of pH:[24]

The pH of the formulated foundation stick was determined using pH paper and pH meter.

Fig 11. Determination of Ph

Spreadability:[25]

Spreadability affects both product efficacy and consumer impression by indicating how easily the formulation distributes on the skin. Spreadability assessed using the Texture Analyser by sandwiching a certain amount of stick between two glass plates and applying a predetermined weight or compressive force. The force-distance curved was created, or the spread diameter was measured.

It calculated by using formula:

S=M*L/T

Where,

S=Spreadability

M=Weight place on slide

L=length of glass slide

T=Time taken in seconds

Fig 12. Spreadability test

Adhesion Test:[26]

An adhesion test is the ability of preparation to adhere on the skin when used. Good preparation has a high adhesion. The indicates the lasting power and film-forming property of the formulation.

Fig.13. Adhesion Test

Melting point:[27]

The melting point of the formulated foundation stick was determined by melting point apparatus.

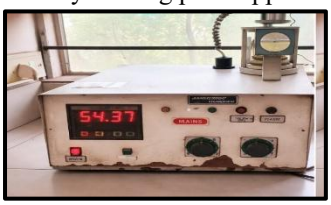

Fig.14. Melting Point

Skin Irritation Test:[28,29]

Formulation foundation stick was applied on the hand to test irritation on the skin.

Washability Test:[30]

This is common method for checking the washability of the formulation. The formulation was applied on the skin and then ease and extend of washing with water were checked manually by using water is used to remove all content of the formulation were applied on the skin.

Fig.15. Washability test

Surface Anomalies:[31]

This was studied by the surface defects, such as formation of crystals on surface, contamination by moulds, fungi, formation of wrinkles, exudation of liquid substances and of solid fatty substances, etc.

Antimicrobial Activity for antiacne properties:[32]

The antimicrobial activity of the formulated foundation stick for evaluating its anti-acne properties was carried out using the agar well (or disc diffusion) method, which is standard

and widely accepted in vitro technique. In this method, acne-causing microorganisms such as Cutibacterium acnes and Staphylococcus aureus were selected as test organisms. Sterile nutrient agar medium was prepared, poured into Petri plates, and allowed to solidify. The bacterial cultures were then uniformly spread over the surface of the agar using a sterile cotton swab to obtain a lawn culture.

Wells of about 6–8 mm diameter were made in the agar using a sterile cork borer, and the foundation stick sample, previously dissolved in a suitable solvent like ethanol, was introduced into the wells. A standard drug such as clindamycin was used as a positive control, while the solvent served as a negative control. The plates were then incubated at 37°C for 24–48 hours. After incubation, the antimicrobial activity was determined by measuring the diameter of the zone of inhibition around the wells. A larger zone of inhibition indicates stronger antimicrobial and antiacne activity of the formulation.

Fig.16. Zone of Inhibition

Preliminary Antioxidant Activity:[32]

Antioxidant ingredients that protect the skin from oxidative stress caused by UV radiation, pollution, and free radicals. Evaluation of Antioxidant Activity in Foundation. Antioxidant activity in foundation is typically measured using DPPH radical scavenging assay FRAP (Ferric Reducing Antioxidant Power) assay CUPRAC method. Evaluated commercial foundation products for antioxidant richness. Found that foundations contain bioactive antioxidant compounds from natural and synthetic sources.

Foundation formulations with antioxidants Provide dual function (cosmetic + protective)

% Inhibition IC_{50} value (concentration needed to inhibit 50%)

IV. RESULT OF EVALUATION

Table.11. Result of Evaluation

Sr.no.	Evaluation Parameters	Result
1.	Physical Appearance	Smooth, uniform, and free from cracks
2.	Colour	Skin tone shade, light beige
3.	Odor	Pleasant and characteristics
4.	Texture	Smooth
5.	pH	6.8 ± 0.10

6.	Spreadability	34 ± 1.0 g cm/ sec(moderate)
7.	Adhesion test	Good
8.	Melting point	53-55 °C
9.	Skin Irritation test	No irritation
10.	Washability test	Washable
11.	Surface anomalies	Absent
12	Homogeneity	Homogenous
13.	Antimicrobial Test	1.2 ± 0.1 (Moderate)
14.	Preliminary Antioxidant Test	Pass

- High % inhibition / low IC_{50} → Strong antioxidant activity
- Moderate activity → Cosmetic benefit but limited therapeutic effect
- Low activity → Mainly aesthetic product

Fig.17. Change in colour of Strong antioxidant ($KMnO_4$)

V. EVALUATION OF MARKETED FOUNDATION STICK

Swiss Beauty Colourscense

Fig.18. Marketed foundation stick

7.2.1. Organoleptic properties:
Colour:
1. Light beige / pale yellow shade
2. Skin tone / natural beige shade
Odor:
1. Mild and pleasant, non-irritating
2.Slight fragrance, no unpleasant or rancid smell
7.2.2. Texture: Both are Smooth[33]
7.2.3. pH determination: Both are neutral

Fig 19. pH test

7.2.4. Determination of Melting point:
Melting point was determined using melting point

Fig.20. Determination of melting point

7.2.5. Spredability:[34] Spreadability test was done with Marketed Foundation.

Fig.21. Spreadability

VI. COMPARATIVE STUDIES

Evaluation parameters compared with formulated with marketed foundation stick.

Table .12. COMPARATIVE STUDIES

Sr. No.	Parameters	Standard value	Formulation foundation stick	Marketed foundation stick	
				Colorscence	Swiss beauty
1.	Colour	Skin tone matching	Light beige	pale yellow shade	natural beige shade

2.	Odour	Mild, Pleasant	Pleasant and characteristics	Mild and pleasant,	Slight fragrance
3.	Texture	Smooth and non-gritty	smooth	smooth	smooth
4.	pH	5.5-7	6.8 ± 0.10	6.8-7.2	6.8-7.2
5.	Melting point	50-60°C	53-55 °C	47-49°C	50-52°C
6.	Spreadability	20-35gcm/sec	34±1.0gcm/sec	26±1.0g cm/sec	28.7±1.0g cm/sec
7.	Skin Irritation	No irritation	No irritation	No Irritation	No irritation
8.	Washability	washable	washable	Washable	Washable
9.	homogeneity	Homogenous	Homogenous	Homogenous	Homogenous
10.	Antimicrobial test	Pass	pass	pass	pass
11.	Surface anomalie	Absent	Absent	Absent	Absent

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