

## Formulation and Evaluation of Herbal Based Sunscreen Stick Containing Persea Americana Oil Extract

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**ABSTRACT:** The present study focuses on the formulation and evaluation of a herbal-based sunscreen stick incorporating Persea americana (avocado) oil extract, known for its natural emollient, antioxidant, and UV-protective properties. The objective was to develop a skin-friendly, stable, and effective topical formulation offering broad-spectrum sun protection using plant-derived ingredients. The sunscreen stick was formulated using a blend of natural waxes, butters, and oils, with Persea americana oil serving as the key active component due to its high content of vitamins A, D, and E, and essential fatty acids. The formulation was evaluated for various parameters, including physicochemical characteristics, spreadability, melting point, pH, stability under different environmental conditions, and in vitro sun protection factor (SPF). The results indicated that the sunscreen stick exhibited favourable physical properties, good stability, and an SPF value indicative of moderate to high protection. The findings support the potential of Persea americana oil as a natural alternative in the development of effective, herbal-based sunscreen formulations.

**KEYWORDS:** Persea americana, sunscreen stick, herbal sunscreen, natural UV protection, SPF evaluation, plant based cosmetic.

### I. INTRODUCTION

Herbal cosmetic also known as "natural cosmetics". The demand of herbal medicines is increasing rapidly due to their lack of side effects. Ayurvedic cosmetic not only beautify skin but act as a protection against external effects for the skin. The best thing is that the herbal cosmetics is purely made by the herbs and shrubs. The natural content of herbs does not have any side effects or reaction on skin or human body; rather it enhances other helpful minerals. There is a large number of cosmetic

formulations have been developed based on Indian Herbs recently.[11]

### ULTRAVIOLET RADIATION:

Sunlight is necessary for living and offers a number of advantages, but it can also harm our skin because it emits ultraviolet rays. Ultraviolet radiation, emitted by the sun, is a form of electromagnetic radiation lies between X-rays and visible light which is from 200-400 nm that reaches the Earth surface. While moderate exposure to sunlight is essential for the synthesis of Vit D and prolong or excessive exposure to UV exposure to UV radiation can affect the skin. UV rays can be categorized into three types depending on the wavelength as follows: UVA, UVB and UVC.

### UV-A Radiation:

These radiation ranges between 320-400 nm. UVA is most responsible radiation for intermediate tanning or darkening of skin due to excess production of melanin in the epidermis, premature photo ageing, suppression of immunologic functions, even necrosis of endothelial cells and damage of dermal blood vessels.[7]

### UV-B Radiation:

These radiation ranges between 280-320 nm. UVB radiations are known as burning rays as they are 1000 times more capable of causing sunburn than UVA. UVB rays act mainly on the epidermal based cell layer of the skin but more genotoxic than UVA radiations. Ultraviolet B (UVB) rays vary with time and season are major cause of sunburn. Sunburned skin is a leading risk factor for melanoma and non-melanoma skin cancer.[7]

### UV-C Radiation:

This radiation ranges 200-280 nm. UV-C radiation is filtered by stratospheric ozone layers so less effective and hazardous.[7]

### Sunscreen

Cosmetics are described as ‘articles supposed to be rubbed, Poured, sprinkled, or sprayed on, delivered into, or otherwise Carried out to the human frame or any component thereof for cleansing, beautifying, selling attractiveness, or changing the appearance’

Among the generally used cosmetics are sunscreens. These are formulations which might be carried out onto the pores and skin floor to defend it from the dangerous results of ultraviolet (UV) light. Repeated publicity of the pores and skin has been related to an excessive risk of growing pores and skin cancers. According to most cancer studies in USA, eight out of 10 instances of cancer might be avoided through an under status of the dangerous results of daylight and a way to defend oneself from the dangerous rays. Of worries to the fitness business around the sector is the growth in excursion sunbathing in addition to the usage of synthetic UV reagents to result in pores and skin tanning amongst younger whites looking for a darker pores and skin. Sun rays encompass an array of wavelengths stages that fluctuate in frequency and their electricity profiles. The sun electromagnetic spectrum includes cosmic rays, gamma rays, X-rays, UV rays, Microwaves, and radio waves in lowering order of electricity. Among those cosmic, gamma and X rays are correctly filtered out of the Earth via way of means of the surroundings and consequently gift no capability for inflicting harm. It is, however, noteworthy that they may be the deadliest and publicity could result in failures of epic proportions. The UV rays can penetrate the earth's surroundings as can the rest of the decrease electricity spectrums. Microwaves and radio waves are now no longer of clinical significance as pertains to inflicting pores and skin harm. The recognition of this newsletter is as a consequence the UV spectrum of light. The UV light is a part of the seen mild and spans the wave duration from a hundred to four hundred nm as proven in Fig. 1 below. The UV spectrum is similarly divided into three; 290–320 nm (UVB) and 320–400 nm (UVA). UV-C occupies a hundred–290 nm of the spectrum; however, it's far of no clinical significance given that it's far completely filtered out via way of means of the ozone layer. UVB triggers the manufacturing of melanin pigment and stimulates the pores and skin cells to supply a

thicker dermis, ensuing in an enduring tan. It is likewise the number one purpose of sunburns. The UVA mild activates melanin already at the dermis to supply a short-time period tan. It penetrates a great deal deeper into the pores and skin than UVB and might.[6]

### Different sunscreen formulation:

1. Emulsion Formulation
2. Gel Formulation
3. Aerosol Formulation
4. Sun-stick Formulation
5. Cream Formulation

### Why sunscreen stick formulation:

The sun stick is undoubtedly one of the most convenient products due to its small size and light weight. The sun stick is produced by two main emulsion components, namely oil and oil soluble components, through the incorporation of petrolatum and waxes. This form is subdivided into three categories, namely transparent, semi-transparent, and matte sunscreen. The transparent formula contains only chemical UV filters, while semi-transparent is formulated mainly by chemical and mineral substances and matte is composed of only mineral sunscreen ingredients.[4]

### Avocado fruit



Fig 1: Avocado fruit

Avocado oil (*Persea americana*) consists mainly of fatty acids where oleic acid is its major component.

Carotenoids, tocopherols, sterols and chlorophylls are found in its composition. Regarding to skin, avocado oil has properties such as antioxidant, anti-aging, anti-inflammatory, and healing. Avocado crude oil is more advantageous than refined crude oil in relation to its skin benefits. Nevertheless, refined avocado oil is the one most used in skin formulations. Under exposure to daylight and thermal exposure, crude avocado oil components suffer degradation, which compromises its skin properties. Also, in the refining process,

Chlorophyll is removed allowing the obtaining of a refined avocado oil which is less susceptible to oxidation by light.

#### Avocado oil use in sunscreens formulation

One nature component that may be utilized to prepare sunscreen and absorb UV-B radiation is avocado oil. Avocado oil has bioactive components that benefit the skin such as Palmitic acid and linoleic acid, which can increase skin moisture and prevent skin erythema. Components of oil are also used to heal inflammation and skin erythema through skin barrier mechanism. Studies had been shown that avocado oil has sunscreen activity with SPF value of 6-16.[9]

Avocado oil is high in mono-unsaturated fats and Vitamin E. Avocado oil enhances the absorption of carotenoids and other nutrients. Originally it is extracted for cosmetic use because of very high skin penetration and rapid absorption. It is rich and extremely penetrating oil, rich in Vitamin A, D and E. It also has high content of sterolins, which are reported to reduce the age spots, heal sun damage and scars.[8]

It is an ideal ingredient to include when formulating for people with dehydration, sun damage skin, as it is extremely good moisturizing and nourishing compound assisting in the regeneration and rejuvenation of the skin.[8]

Avocado oil is easily absorbed into deep tissue, and with its wonderfully emollient properties make it ideal for mature skins. It also helps to relieve the dryness and itching of psoriasis and eczema. It is very useful when treating sun or climate damaged skin that is dehydrated and undernourished, as it is said to help with regenerating the skin and softening the tissue.[8]

## II) MATERIAL AND METHOD

### A) Selected ingredients formulation of herbal sunscreen stick

#### 1. AVOCADO OIL EXTRACT

##### Synonym:

Avocado butter fruit, Alligator pear

##### Biological source:

It is a fruit obtained from evergreen tree that belongs to family Lauraceae also called laurel family.

##### Chemical constituent:

Avocado oil is primarily composed of fatty acids, with oleic acid being the most abundant. It also contains palmitic acid, linoleic acid, and smaller amounts of other fatty acids like

docosadienoic acid, palmitoleic acid, linolenic acid, and eicosenoic acid



Fig 2: Avocado

##### Uses:

Avocado oil has bioactive components that benefit the skin such as Palmitic acid and linoleic acid, which can increase skin moisture and prevent skin erythema. Components of oil are also used to heal inflammation and skin erythema through skin barrier mechanism. Studies had been shown that avocado oil has sunscreen activity with SPF value of 6-16.

## 2. BEES WAX:

##### Synonyms:

Cera-alba, linseed-oil, honeycomb wax, natural wax, white wax, yellow wax.

##### Biological source:

The primary biological source of beeswax is the honeycomb, specifically species like *Apis mellifera* and *Apis dorsata* and other members of the family.

##### Chemical constituents:

Beeswax is a complex mixture of various chemical compounds. Unhydrolyzed Beeswax consists of approximately 71% esters, 15% hydrocarbon, 8% free fatty acids, 6% other compounds.



Fig 3: Bees wax

##### Uses:

Beeswax is widely used in cosmetics for its emulsifying, emollient, and consistency-enhancing properties. It helps to create stable

emulsions, soften and moisturize the skin, and thicken formulations like creams and lip balms. Additionally, beeswax can act as a protective barrier on the skin, helping to lock in moisture and shield against environmental irritants.

### 3. COCOA BUTTER:

#### Synonyms:

Theobroma oil, cacao butter, cacao beans, semina Theobroma

#### Biological source:

It is obtained from roasted seeds of Theobroma cacao Linn., belonging to family Sterculiaceae.

#### Chemical constituents:

It consists of glycerides of stearic (34%), palmitic (25%), oleic (37%) acids, and small amount of linoleic acids and arachidic acid. Glyceride structure is responsible for non-greasiness of product.



Fig 4: Cocoa butter

#### Uses:

It is used as an emollient, as a base for suppositories and ointments, manufacture of creams, and toilet soaps. It reduces the formation of stretch marks during pregnancy by keeping the skin supple. It is used as an ingredient in lotion bars, lip balms, body butters, soaps, and belly balms for expectant mothers.

### 4. ALOE VERA GEL:

#### Synonyms:

Aloe barbadensis, Aloe spica

#### Biological source:

The Biological source of aloe is dried latex of leaves of various species of aloes namely: Aloe barbadensis and family Asphodelaceae(Liliaceae).

#### Chemical constituents:

Aloe vera contains over 200 chemical constituents. The two-main active constituents of the aloe vera plant extract are chromone and anthraquinone and its glycoside derivatives.



Fig 5: Aloe vera gel

#### Uses:

It has antioxidant and antibacterial properties. Its also improves skin and prevents wrinkles. Aloe vera is used as a cooling effect in cosmetics.

### 5. VITAMIN E CAPSULE:

#### Synonym:

Tocopherol



Fig 6: Vit E capsule

#### Uses:

Strengthens your skin barrier. A strong skin barrier allows your skin to retain water and stay hydrated, Super moisturising, Powerful antioxidant properties, Treats hyperpigmentation, Protects from UV exposure

### 6. COCONUT OIL:

#### Synonym:

Coconut oil, coconut butter, copra oil

#### Biological source:

Coconut oil is the oil expressed from the dried solid part of endosperm of coconut, Cocosnucifera L., belonging to family Palmae.

**Chemical constituents:**

Coconut obtained from the hard, dried endocarp consists of a mixture of triglycerides of saturated fatty acids. The oil contains about 95% of saturated fatty acids with 8 and 10 carbon atoms. It shows the presence of caprylic acid, 2%; capric acid, 50–80%; lauric acid, 3%; and myristic acid about 1%.



Fig 7: Coconut oil

**Uses:**

Coconut oil for face is popular as it is highly moisturising and can also reduce inflammation, counteract free radical damage and prevent infection. Not only this but coconut oil for face can boost the production of collagen which

helps to firm skin and reduce the appearance of fine lines and wrinkles.

**7. ZINC OXIDE:**



Fig 8: Zinc oxide

**Uses:**

Zinc oxide is a key ingredient in mineral or physical sunscreens, used to protect the skin from harmful UV rays. It works by reflecting and scattering UV radiation away from the skin, forming a protective barrier on the surface. This process helps prevent UV rays from penetrating and causing damage like sunburn, premature aging, and increased risk of skin cancer.

muslin cloth and the resultant oil was centrifuged and collected.[10]

**B. FORMULATION**

INGREDIENT	QUANTITY
<b>OIL PHASE</b>	
a) Avocado oil extract	4.47 ml
b) Cocoa butter	3g
c) Bees wax	5g
d) soft paraffin wax	1g
e) Non-nano zinc oxide	4g
<b>AQUEOUS PHASE</b>	
a) Aloe vera extract	1g
b) Vit E	1 capsule
c) Coconut oil	1ml
d) Rose oil (Fragrance)	Q. S

**C. METHOD OF PREPARATION:**

**Extraction of avocado oil:**

Approx 4 to 5 ripe avocado were taken from the market and were peeled with a peeler, the seeds were removed and then the pulp was scooped out into a manual grinder which turned it into a paste. The paste was then transferred into a beaker and then placed on the water bath at 75-80 degree Celsius. It was left on the water bath for 3 days to evaporate the water content. After the water had evaporate, the avocado paste was pressed through a



Fig 9: Extraction of oil

**Preparation of sunscreen stick:**

1. Weight all Oil phase (Avocado oil, Cocoa butter, Bees wax, soft paraffin) Place them in a beaker and heat with vigourously stirring at 70° C.[1] Once fully melted, slowly add Zinc oxide while continuously stirring for 3-5 min for uniform mixture. Remove

from heat and let the mixture cool to about 40°C to prevent degradation of Extract.

2. Aloe vera, Vit E and Essentials oil was added for skin benefits. Mix well to ensure all ingredients are evenly distributed.

3. Immediately pour the warm liquid into twist-up mould. Kept it in the deep freezer for 10-15 min to harden. Final products are formed. Store the products in cool and dry place.

### III. EVALUATION

#### A) Avocado oil:

##### 1. Physiochemical properties

##### 1.1 Determination of Fatty Acid

25 ml of diethyl ether was mixed with 25ml alcohol and 1ml phenolphthalein (1%) and carefully neutralize with 0.1 M KOH shaking constantly until pink colour which persisted for 15 seconds was obtained..[3]

The Acid value was calculated as

$$= \frac{\text{Titre volume (ml)} \times N \times 56.1}{\text{Weight of sample used}}$$

##### 1.2 Determination of Saponification Value

2g of oil was weighed and introduced into a conical flask and added with 25ml of the alcoholic potassium hydroxide solution.

A reflux condenser was attached and the flask heated in boiling water for 1hr, with intermittent agitation then about 1 ml of phenolphthalein (1%) solution added and the hot excess alkali titrated with 0.5M HCL giving titre value as =A ml

A blank titration was carried out at same time with titre value as=B ml. [3]

The saponification value was calculated as

$$= \frac{(B-A) \times 28.05}{\text{Weight(g) of sample}}$$

##### 1.3 Determination of Iodine value

1.5 ml of potassium iodine solution (10%) was added with 100ml water, properly mixed and titrated with 0.1M thio-sulphate solution using starch as indicator.

Volume at the titration end-point was designated as = A ml. A blank titration was also carried out at the same time commencing with 10ml Of carbon tetrachloride and titre volume is designated as = B ml.[3]

$$\text{Iodine value} = \frac{(B-A) \times 1.269}{\text{Weight (g) of sample}}$$

##### 1.4 Determination of peroxide value

1g of oil was weight and introduced into a clean dry boiling tube and while stirring 1 g of powdered potassium iodide and 20 ml of solvent mixture (2ml of glacial acetic acid 1ml volume chloroform) was added. The tube was placed in boiling water and the liquid allowed to boil vigorously for not more than 30 seconds after which the content was transferred immediately into a flask containing 20 ml of potassium iodide solution (5%), the tube washed twice with 25 ml water and titrated with 0.002M sodium thiosulphate solution using starch..[3]

$$\text{Peroxide value} = \text{Titre value} \times 2$$

##### 2. Anti-microbial study

Prepare a culture of the micro-organism that you want to test the oil against (eg Escherichia Coli) Incubate the agar plate with the microorganism by spreading a small amount of the culture evenly across the surface of the agar using a sterile swab. Using a sterile cork borer or similar tool, make wells in the agar plate. Place a small amount of oil in one well and other well with standard using a sterile applicator stick. Incubate the plate at an appropriate temperature for the microorganism. (e g 37°C) for a specified period of time (e g 24 hours) Measure the diameter of the zone of inhibition around well where no growth is present. This indicates the antimicrobial activity.



Fig 10: Anti-microbial test of oil

##### 3. FTIR study

FTIR technique was applied to determine the functional groups present in the avocado In Fig:11 the FTIR studies showed intensive absorption peaks for avocado oil located at 3468, 2924, 2854, 1745, 1463, 1377, 1161, 1112 and 722 cm<sup>-1</sup> are very similar to the studies performed with avocado oil (Quiñones-Islas et al., 2013; dos Santos et al., 2014). The presence of absorbance peak at 3468 cm<sup>-1</sup> is due to bands arising from cis C-H stretching, whereas 2924 and 2854 cm<sup>-1</sup> for asymmetric and symmetric C-H/CH<sub>2</sub>

stretching vibrations, respectively. The strong peak at  $1745\text{cm}^{-1}$  arises from C-O stretching vibrations of aldehydes and ketones from triglycerides and polyphenols. The absorbance bands at  $1463$  and  $1377$  arise from  $\text{CH}_2$  and  $\text{CH}_3$  scissoring vibration, while those at  $1161$ ,  $1112$  are associated

with the C-O stretching vibrations of ester (Kumar et al., 2010, 2018). The small peak at  $722\text{cm}^{-1}$  corresponding to the  $-\text{CH}_2$  rocking and out of plane vibration of cis-distribution olefins (Ozdemir and Topuz, 2004) [5]

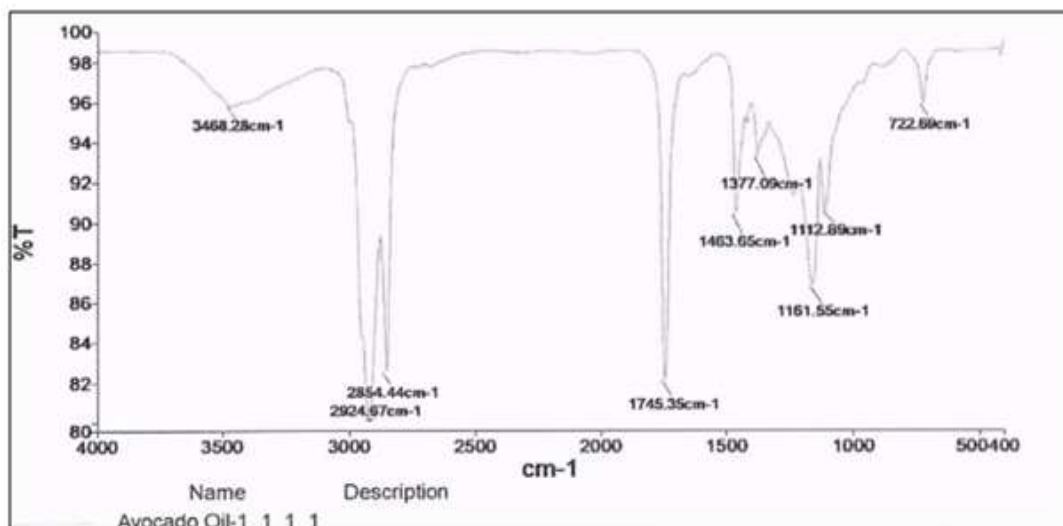


Fig 11: FTIR of avocado oil

## B) Sunscreen stick

### 1. Physical Examination:

**Colour:** The colour of formulation was checked manually and observed.

**Odour:** The smell of Formulation was checked by applying preparation on hand and feel the fragrance.

**Appearance:** Visually checked the appearance of the formulation.

**Smoothness:** The smoothness was tested by rubbing the stick formulation on the hand.

**Force of application:** Visually checked by applying on hand.

**Solubility:** It is soluble in chloroform and alcohol.

**Melting point:** The sunscreen sticks usually melt at  $45^{\circ}$ - $55^{\circ}\text{C}$ .

### 2. pH determination:

The pH of sunscreen was determinant using a digital pH meter. The pH was measured after 1g of the formulation was dissolved in 100ml of newly prepared distilled water for 2 hours. The purpose of this study was to guarantee that pH of the produced herbal sunscreen is similar to the pH of the skin after 24 hours of use. The result was checked and was recorded. [1]



Fig 12: pH of sunscreen stick

**3. Washability:** This test is carried out by simply washing applied sunscreen with water. [6]

**4. Homogeneity:** The formulation was tested for homogeneity by visual appearance and touch. [6]

**5. Irritancy test:** Mark an area (one sq. cm) on left hand dorsal surface. The sunscreen was applied to the specific area and time was noted. Irritancy, erythema, oedema was checked if any for regular interval up to 24 hrs and reported. [6]

### 6. Anti-microbial test:

Prepare a culture of the microorganism that you want to test the sunscreen against (e.g., Escherichia Coli) Incubate an agar plate with microorganism by spreading a small amount of the culture evenly across the surface of the agar using a

sterile swab. Using a sterile cork borer or similar tool, make wells in the agar plate. Place a small amount of sunscreen formulation one well and marketed sunscreen in another well using sterile applicator stick. Incubate the plate at an appropriate temperature for the microorganism (e.g. 37°C) for a specific period of time (e.g., 24 hrs). Measure the diameter of zone of inhibition around each well where no growth is present. This indicates the antimicrobial activity of the formulation.



Fig 13: Anti-microbial test of sunscreen stick

**7. Sun protection factor:**

1 g of formulation was taken and weight in 100 ml volumetric flask. The formulation was diluted with 100 ml of ethanol and sonicate for 30 to 45 minutes. After sonication the first 10 ml was discarded and then 5 ml of adequate was transferred to 50ml volumetric flask and volume was made up. From this again 5 ml of aliquot was transferred to 25ml volumetric flask and volume was made up. The absorbance was checked in UV spectrophotometer. Absorbance was measured in the UV-B wavelength range (290-320nm) in 5 nm interval. In-vitro Sun protection factor determination (absorbance method) by UV-Spectrophotometer, SPF by Mansur equation.[1]

$$SPF = CF \times \sum_{320-290} EE \times I \times Abs$$

I = Solar intensity spectrum

Abs = Absorbance

C.F = Correction factor

EE = Erythmal effect of spectra

**8. Stability:**

The formulation was subjected to accelerated stability conditions by storing it at room temperature for several days. Any change or instability were recorded.



Fig 14: Stability study

**IV. RESULT AND DISCUSSION**

**A) Physiochemical study result**

Sr.no	Parameter	Result
1.	Acid value	0.84mg KOH/g
2.	Saponification value	197.7 mg KOH/g
3.	Iodine value	78.67 gI2/100g
4.	Peroxide value	6.4 meqO2/kg

**B) Result of anti-microbial test of oil**

The anti-microbial test of oil shows moderate inhibition. Hence the avocado oil exhibit significant anti-microbial properties.

**C) FTIR result**

The FTIR spectrum of Persea americana (avocado) oil extract, as shown in Figure 11. confirms the presence of characteristic functional groups consistent with the known composition of avocado oil. The analysis revealed the following major absorption peaks:

- 3468.28 cm<sup>-1</sup>: Broad peak indicating O–H stretching vibrations, typically associated with hydroxyl groups from phenolic compounds and alcohols.
- 2924.57 cm<sup>-1</sup> and 2854.44 cm<sup>-1</sup>: C–H stretching vibrations of aliphatic –CH<sub>2</sub> and –CH<sub>3</sub> groups, indicating the presence of long-chain fatty acids and triglycerides.
- 1745.35 cm<sup>-1</sup>: Strong peak corresponding to C=O stretching of ester groups, which are prominent in triglycerides and fatty acid esters.
- 1463.65 cm<sup>-1</sup> and 1377.09 cm<sup>-1</sup>: C–H bending vibrations, further confirming aliphatic chains.
- 1161.55 cm<sup>-1</sup> and 1112.85 cm<sup>-1</sup>: C–O stretching vibrations, indicative of esters and alcohols.

•722.69 cm<sup>-1</sup>: A characteristic peak due to long-chain alkyl bending, supporting the presence of saturated fatty acids.

The spectral profile confirms the presence of key functional groups relevant to fatty acids,

esters, and alcohols, all of which contribute to the emollient, antioxidant, and potential UV-protective properties of avocado oil. No significant peak shifts were observed, suggesting the oil maintained its structural integrity within the formulation.

#### D) Physical study

Sr. No.	Parameter	Result
1	Color	Off white-greenish in color
2	Odor	Pleasant
3	Appearance	Good
4	Smoothness	Soft texture
5	Force of application	Easily applicable on skin
6	Solubility	chloroform and alcohol
7	Melting point	55°C - 60°C
8	Wash ability	Easily washable
9	Homogeneity	Good
10	Iritancy test	No irritation
11	Anti-microbial test	No microbial growth

#### E) SPF calculation:

SR.NO	Wavelength	EE*I	Absorbance	EE*I*Abs
1.	290	0.0150	2.3780	0.0356
2.	295	0.0817	2.2747	0.1858
3.	300	0.0287	2.2293	0.6242
4.	305	0.3278	2.2516	0.7205
5.	310	0.1864	3.1139	0.5605
6.	315	0.0839	2.5923	0.2073
7.	320	0.0180	2.3924	0.0239
Σ		1		2.35

$$\begin{aligned}
 \text{SPF} &= \text{CF} \times \sum_{290-320} \text{EE} \times \text{I} \times \text{Abs} \\
 &= 10 \times 2.36 \\
 &= \mathbf{23.5}
 \end{aligned}$$

#### Conclusion:

The tested formulation showed an SPF of 23.5, indicating medium protection. This suggests the product can effectively protect against UV-B induced sunburn

#### F) Stability

The sunscreen stick remains stable at evaluated temperature of 36-40°C for 28 days, with no significant changes in colour, Spreadability, appearance and fragrance.



Fig 15: Herbal sunscreen stick

## V. CONCLUSION

The herbal sunscreen stick containing avocado oil was successfully formulated using natural and skin-friendly ingredients such as cocoa butter, beeswax, zinc oxide, and aloe vera. Avocado oil served as a key emollient, offering moisturizing properties along with a mild natural SPF due to its rich content of antioxidants and unsaturated fatty acids. The formulation demonstrated satisfactory physical characteristics including uniform consistency, smooth application, and good spreadability. The incorporation of zinc oxide provided effective broad-spectrum UV protection, while the FTIR analysis confirmed the presence of functional groups typical of fatty acid esters and antioxidant components. The product exhibited moderate antimicrobial activity,

good stability, and an estimated SPF in the range suitable for daily, non-intensive sun exposure.

Overall, the herbal sunscreen stick proved to be a promising natural alternative to conventional sunscreens, combining sun protection with skin nourishment and soothing properties. Further work may include in vitro SPF testing, stability studies under accelerated conditions to validate the formulation for commercial or therapeutic use.

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