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Formulation and Evaluation of Cost Effective Polyherbal Sunscreen Gel Using Avocado Oil, Tea Tree Oil and Aloe Vera Extract

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ABSTRACT:

The primary aim of this study was to evaluate the potential for developing a Polyherbal Sunscreen Gel with *Avocado* oil, *Tea tree* oil, and *Aloe vera* extract. Various formulations were prepared through adjusting the Carbopol concentration. The pH, spreadability, viscosity, sunscreen activity and stability measurements were taken for the tested formulations. Consequently, all the parameters confirmed pass. The formulation displayed excellent sun blocking properties and was proven to be efficient in fighting sunburn and pigmentation; and therefore, can be employed as a sunscreen.

Keywords: Avocado, Tea tree, Aloe vera, sunscreen, gel, spreadability, sunburn.

INTRODUCTION

Human skin is the most exposed part of a person, and previously conducted tests on skin cells that are carried out in vitro and in vivo have already shown that its molecules and structures can be damaged caused by ultraviolet (UV) radiation. When it comes to the skin, some part of ultraviolet radiation gets reflected and another portion is absorbed into various levels of the skin. [1]

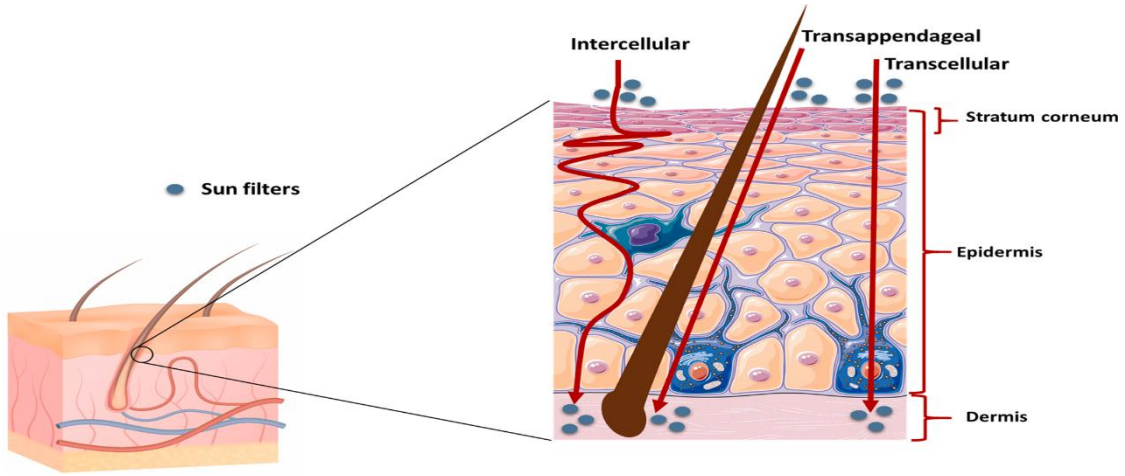

Fig.1: Illustration of the skin structure, focusing on the different layers and emphasizing the key ways substances can pass through the skin, such as through cells, between cells, and through appendages.

Sunburns occur when the skin is exposed to excessive ultraviolet (UV) rays, a rare condition. Among the ultraviolet rays in the sun, UVA rays have the most considerable proportion with a wavelength ranging between 320nm to 400nm while approximately half of these reach the outer layer of the skin that is called epidermis. The extent of erythema generated by sunlight on the skin depends on the quantity of UV energy taken in by the skin. Normally, redness begins after a latency period of 2-3 hours and peaks between 10-24 hours post exposure. The most pronounced effect of sun rays on the skin is initially redness followed by tanning. The formation of a tan on the skin is a way the body protects itself from the harmful effects of sunlight.[2] According to studies, skin pigmentation alterations can result from exposure to solar ultraviolet radiation (UVR; ~295–400 nm). More recent research has demonstrated that visible light (VL; 400–740 nm) may also be associated with quick pigmentation. [3][4] One of the most important factors determining one individual's UV sensitivity and the risk for skin cancer is the complexion of their skin. The Fitzpatrick scale is composed of six phototypes that describe a spectrum of skin colours based on its basal tone, melanin content, inflammatory response to UV and risk for cancer. [5] "Photoaging affects individuals of all skin tones, but is typically less severe or occurs later in people with darker skin." [6] Rapidly the aging of the population of the globe is increasing. Increased risk of tumor development accompanies aging. "The process of natural skin aging is different from skin aging caused by external factors like UV radiation. UV radiation is the primary environmental factor contributing to skin aging.".[7] Photoaging drastically decreases skin beauty and causes several skin disorders.[8]

Preparation with active ingredients obtained from natural sources has both sunscreen and skin anti-aging effects when applied to the skin, providing a wide range, such as protection from UV light (sunscreen effect) and reduction of reactive oxygen species that cause aging as an antioxidant effect. Nowadays, it is very handy and practical to use cosmetics with two effects of shielding against sunlight activities as well as having components that prevent aging signs at the same time.

The avocado fruit is originally from Southern Mexico and Central America and is a member of the Laureaceae family.[9] Concerning the properties of avocado extract as sunscreen, avocado oil is quickly absorbed into the skin and is regarded as suitable for muscle oils, creams for tissues and massage as well as other products needing penetration and lubrication."[10] Tea tree oil contains around 100 different compounds primarily consisting of monoterpene along with their corresponding alcohols, such as terpinen-4-ol constituting 30-40% of TTO. [11] The plantain leaf has several traits including easing pain, reducing inflammation among others. Therefore, the most common use is dealing with skin conditions ranging from insect bites, cuts, eczema to acne.[12] Aloe vera has been applied on the skin to heal different skin problems like injuries, burns and eczema.[13] The products are available in spray, cream, gel, lotion, capsule, liquid. Sunburn pain can be reduced effectively by Aloe Vera. Sunburns can be treated using fresh gel extracted from the Aloe Vera plant or lotions containing it.[14] Aloe vera leaves contain a variety of important components, including phenolics, enzymes, vitamins, saccharides, and low molecular weight substances. [15]

Gels are a type of topical medication that can be applied properly and have much better stability when you compare them with creams and ointments. When compared to other types of semi-solid formulations, gels also provide a way to release drugs in a controlled manner.[16] Gel formulations are used to apply drugs to the skin because they are simple to use, keep in contact with the treated region for longer periods of time, and have less adverse effects than other topical preparations or oral medications.[17]

MATERIALS AND METHODS

Materials

Avocado oil and *Tea tree* oil were collected from S.R. Scientific House Rambagh, Agra. We collected aloe vera leaves from the plant curved in the medicinal garden campus of IIMT University, Meerut. We used Carbopol 934(gelling agent), Glycerine (wetting agent), Methyl and propylparaben (preservatives) and propylene glycol (permeation enhancer). We added triethanolamine to set a pH level of 6.8-7 in the desired range of pHs.

Preparation of Gel

Avocado oil, *tea tree* oil and *aloe vera* extract formulation was composed. In addition to the above, other components include Carbopol 934 (as a gelling agent), Methylparaben (which acts as an anti-microbial agent), Propylparaben with Glycerin serving as a humectant, Propylene Glycol for skin penetration enhancement purposes and Triethanolamine to keep the pH levels within the desired range (6.8 -7). The formulation is made by mixing particular amounts of avocado oil, tea tree oil, and aloe vera extract. Glycerine and propylene glycol should be added next, followed by heating. Warm water and Carbopol were combined in another beaker and swirled on a hot plate. Finally, move the former beaker into the latter, add methyl and propyl paraben, and mix them together, followed by triethanolamine additions. Check the pH afterwards to ensure it is correct.**[10]**

Table.1: List of chemicals and ingredients

Sr.no.	Name of Ingredients	Quantity to be taken				
		F1	F2	F3	F4	F5
1.	Avocado oil	1.0 mL	1.0 mL	1.0 mL	1.0 mL	1.0mL

2.	**Tea tree oil**	1.0 mL	1.0 mL	1.0 mL	1.0 mL	1.0 mL
3.	**Aloe vera extract**	1.0 mL	1.0 mL	1.0 mL	1.0 mL	1.0 mL
4.	**Carbopol 934**	1.50 gm	2.0 gm	2.50 gm	3.0 gm	3.50 gm
5.	**Polyethylene glycol**	5.0 mL	5.0 mL	5.0 mL	5.0 mL	5.0 mL
6.	**Methyl paraben**	0.50 mL	0.50 mL	0.50 mL	0.50 mL	0.50 mL
7.	**Propyl paraben**	0.050 mL	0.050 mL	0.050 mL	0.050 mL	0.050 mL
8.	**Triethanolamine**	1.50 mL	1.50 mL	1.50 mL	1.50 mL	1.50 mL
9.	**Water**	q.s.	q.s.	q.s.	q.s.	q.s.

Evaluation of Gel

Physical examination

The prepared gels were visually evaluated for color and odor. [18] [19]

Homogeneity

During a gel-setting process, once all the gels were set in the container, homogeneity in all the produced gels was evaluated through visual examination. This examination involved observing their appearance and looking for any aggregations**.**[20]

Grittiness

All formulations were examined for the presence of particles using a light microscope, if any; none of them showed any appreciable amount of particulate matter. Therefore, it is clear that the gel preparation meets the requirements for lack of particular matter and grittiness that are necessary for any topical preparation. [19]

Determination of pH

A digital pH meter is used to detect the pH value of the formulation, and then immersed the glass electrode entirely in the gel system, covering it completely. The pH of five separate gels were then determined.

Determination of Spreadability

We used two sets of normal glass plate slides, each measuring 20 × 20 cm. We placed 0.5 grams of the gel formulation on one of the slides. Then another slide was put up in such a way that it covered the gel, hence trapping it between the two slides. 125 g was used to press down upon the top plates for 5 minutes thereby ensuring that the thin layer was formed by the homogeneously pressuring gel between them.

$S = M \times L / T$

Where;

S = spreadability

M = wt. tied to upper slide

L = length of glass slide

T = time taken to separate slide

Shorter time interval, to cover distance of 6.5 cm, indicates better spreadability**.**[21]

Determination of Viscosity

The tool was used to find out how thick the gel was, and it was done by measuring its viscosity. The container was round and held 50 grams when it was filled with gel, then it was put into a 100 ml beaker. The T-bar spindle was carefully placed straight down from the middle of the beaker without the risk of touching its bottom by itself nor any other part of it. The viscosity affects some few parameters such as temperature, pressure and sample size. At 200rpm (rounds per minute), the spindle turned round.

Extrudability

Standard capped collapsible aluminum tubes were filled with gel formulations and sealed by crimping the ends; we also noted the weights of the tubes. After about equal amounts of weight (long tube intercept length along x-axis) ice cold water was distilled for washing off excess salting jelly squeezed into strainer through a plastic cup without actually touching it directly. Then retransfer each strainer containing only squeezed jelly into petri dishes using forceps. These tubes' weights were also noted prior to them being clamped between two glass slides to produce a 0.5 gram weight, after which their caps were removed to reveal the contents. Here we collected and weighed off any extra gel that had been squeezed out from one end onto the other fresh slide and capped. We calculated percent extruded gel (>90%: excellent; >80%: good; >70%: fair).[22]

In vitro Drug release

In order to better understand the dissolving release of gels across a cellophane membrane, we conduct the diffusion experiments of the gel in a Franz diffusion cell. Diffusion investigations were conducted using a 0.5g sample of gel in a cellophane membrane at 37±1˚C and a dissolution medium of 250 ml of phosphate buffer solution with a pH of 7.4. At 1, 2, 3, 5, 6, 7, and 8 hours, 5 milliliter amounts were periodically taken from each sample, and each quantity removed was quickly replaced with an equal volume of brand-new dissolving fluid. Then, using phosphate buffer as a reference, the amount of medication in the samples was determined.[23]

UV spectrophotometric method

"Generally, two types of in vitro methods are used. This describes how absorption or transmittance measurements can be made for UV radiation in sunscreen products deposited on quartz plates or biological membranes. The absorbance behaviours of the agents within sunscreen layers are evaluated by spectrophotometrically analysing diluted solutions. A very simple UV spectrophotometrically based mathematical relationship was described by Mansur et al. (1986).". The following equation was given by Mansur

$$\mathbf{SPF = C \times \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times Abs(\lambda)}$$

EE = Erythemal Effect Spectrum
I = Solar Intensity Spectrum
Abs = Spectrophotometric Absorbance
CF=Correction Factor (= 10)
The values of EE x I are constants

Stability study

Freeze-thaw cycling was used to conduct stability tests on all the formulations made as gels. Syneresis was observed when, after subjecting the product to 4˚c for a month as well as 25˚C for a month following that up with 40˚c for the same time period of one month, the product

was again taken through 25˚C for a month then followed by 40˚c for this same duration. Liquid exudates separating from them are noticed when these polymers are exposed at its current room temperatures even while undergoing separation phase just after brief exposure.

RESULT AND DISCUSSION

Pre-formulation Studies

Phytochemical screening of avocado oil, tea tree oil and aloe vera extract

Table.2: Qualitative phytochemical constituents of Persea Americana

Sr.no.	Phytochemical compound	Result
1.	Tannins	+ve
2.	Saponins	-ve
3.	Terpenoids	+ve
4.	Alkaloids	-ve
5.	Flavonoids	+ve
6.	Steroids	+ve
7.	Phenols	+ve
8.	Anthraquinones	-ve
9.	Cardiac glycosides	-ve
10.	Reducing sugars	-ve

+ve = presence -ve = absence

Table.3: Qualitative phytochemical constituents of melaleuca alternifolia

Sr. no.	Phytochemical compound	Results
1.	Saponins	+ve
2.	Terpenes	+ve
3.	Flavonoids	+ve
4.	Alkaloids	+ve
5.	Glycosides	+ve
6.	Tannins and phenolic compound	+ve
7.	Phenols	+ve
8.	Anthraquinones	-ve

+ve = presence -ve = absence

Table.4: Qualitative phytochemical constituents of Aloe Vera extract

Sr. no.	Phytochemical compounds	Results
1.	Alkaloids	+ve
2.	Flavonoids	+ve
3.	Saponins	+ve

4.	Terpenoids	+ve
5.	Glycosides	+ve
6.	Tannins	+ve
7.	Steroids	Not detected
8.	Volatile oil	Not detected

+ve = presence -ve = absence

Incompatibility study

Fourier transform infrared spectroscopy (FTIR)

The drug and excipient were studied for compatibility at room temperature with Fourier Transform Infrared Spectroscopy (FTIR) to determine drug excipients/polymer interactions, as well as the drug- drug interaction in the formulation.

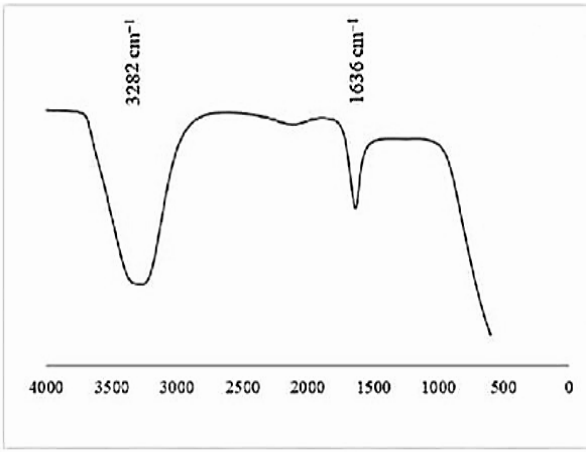

Fig.2: FTIR of avocado

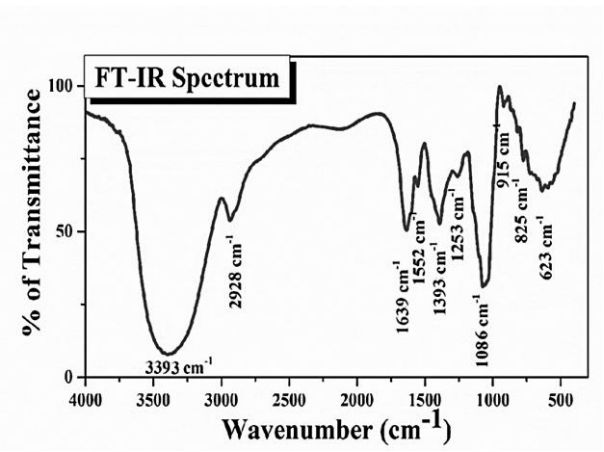

Fig.3: FTIR of tea tree oil

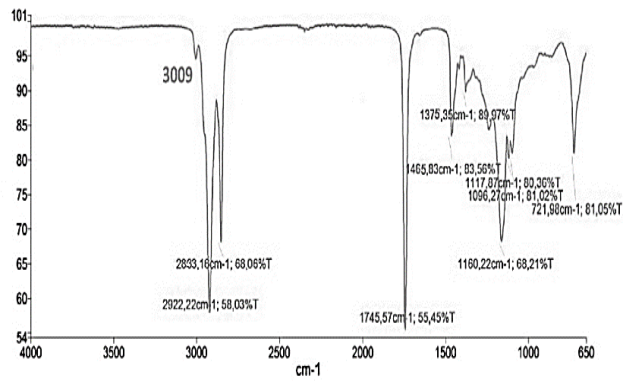

Fig.4: FTIR of aloe vera

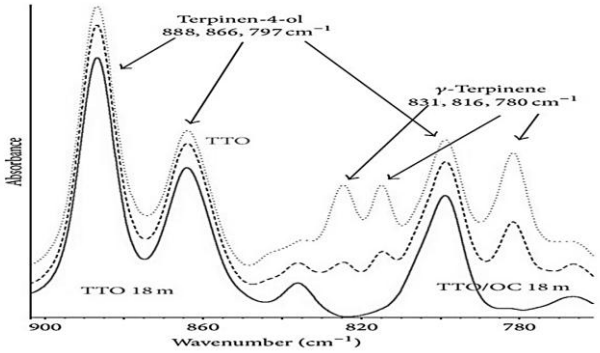

Fig.5: FTIR of Polyherbal Gel

Table.5: Infrared spectral of extract and polyherbal gel

Sr. No.	Name of component	Functional group	Wave no. observed
1.	Avocado oil	C=O (Carbonyl group)	1624.31
2.	Tea tree oil	C=O (Carbonyl group)	1612.06
3.	Extract of Aloe vera	C=O (Carbonyl group)	1608.54
4.	Polyherbal sunscreen gel	C=O (Carbonyl group)	1620.67

Table.6: UV spectroscopy of used oil and extract

Sr. No.	Name of oil/extract	Absorbance	Wavelength
1.	Avocado oil	0.467±0.0012	224.0
2.	Tea tree oil	0.293±0.0025	215.0
3.	Aloe vera extract	0.108±0.0021	221.0

Table.7: UV spectroscopy of Polyherbal gel formulation

Sr. No.	Concentration	Absorbance	Wavelength (nm)
1.	1%	0.373±0.0042	246.0
2.	1.5%	0.367±0.0071	241.0
3.	2%	0.380±0.0037	254.0
4.	2.5%	0.366±0.0046	238.0
5.	3%	0.376±0.0091	226.0

Evaluation of Gel

Physical examination

Table.8: Physical Examination of Gel

Sr. No.	Formulation	Colour	Odour
1.	F1	Pale green	Characteristic
2.	F2	Pale green	Characteristic
3.	F3	Pale green	Characteristic
4.	F4	Pale green	Characteristic
5.	F5	Pale green	Characteristic

Homogeneity, Grittiness and pH of gel

Table.9: Homogeneity, Grittiness and pH of gel

Sr. No.	Formulation	Homogeneity	Grittiness	pH
1.	**F1**	Excellent	Non-gritty	6.9
2.	**F2**	Excellent	Non-gritty	6.9
3.	**F3**	Excellent	Non-gritty	6.7
4.	**F4**	Good	Gritty	6.6
5.	**F5**	Good	Gritty	6.8

Determination of Spreadability and extrudability of gel

Table.10: Spreadability value and percentage extrudability of gel

Sr. No.	Formulation	Spreadability gm.cm/sec	% Extrudability
1.	**F1**	17.66±0.27	87%
2.	**F2**	18.58±0.74	83%
3.	**F3**	19.75±0.66	84%
4.	**F4**	16.53±0.54	89%

5.	**F5**	15.44±0.83	88%
6.	**Marketed gel**	19.89±0.77	87%

***In vitro* drug release studies**

Table.11: *In vitro* drug release of polyherbal gel formulations

Time (min)	% cumulative drug release				
	F1	**F2**	**F3**	**F4**	**F5**
1	19.94±0.24	17.12±1.30	19.05±1.13	19.64±1.27	17.17±1.25
2	27.62±1.34	24.47±1.45	27.14±1.77	26.12±1.23	29.53±1.75
3	36.47±1.34	39.42±2.04	35.88±1.74	33.64±1.36	37.57±1.78
4	46.93±1.47	44.33±1.86	41.29±1.08	41.75±1.74	44.55±1.33
6	58.65±1.47	50.92±1.29	49.85±1.92	48.93±1.24	47.54±1.43
8	64.22±1.39	57.53±1.08	54.62±1.44	52.62±1.73	51.362±1.44
10	68.53±1.14	62.53±1.42	60.86±1.06	59.33±1.25	56.22±1.82
12	72.63±1.83	67.27±1.93	64.66±1.44	63.64±1.23	62.84±1.12

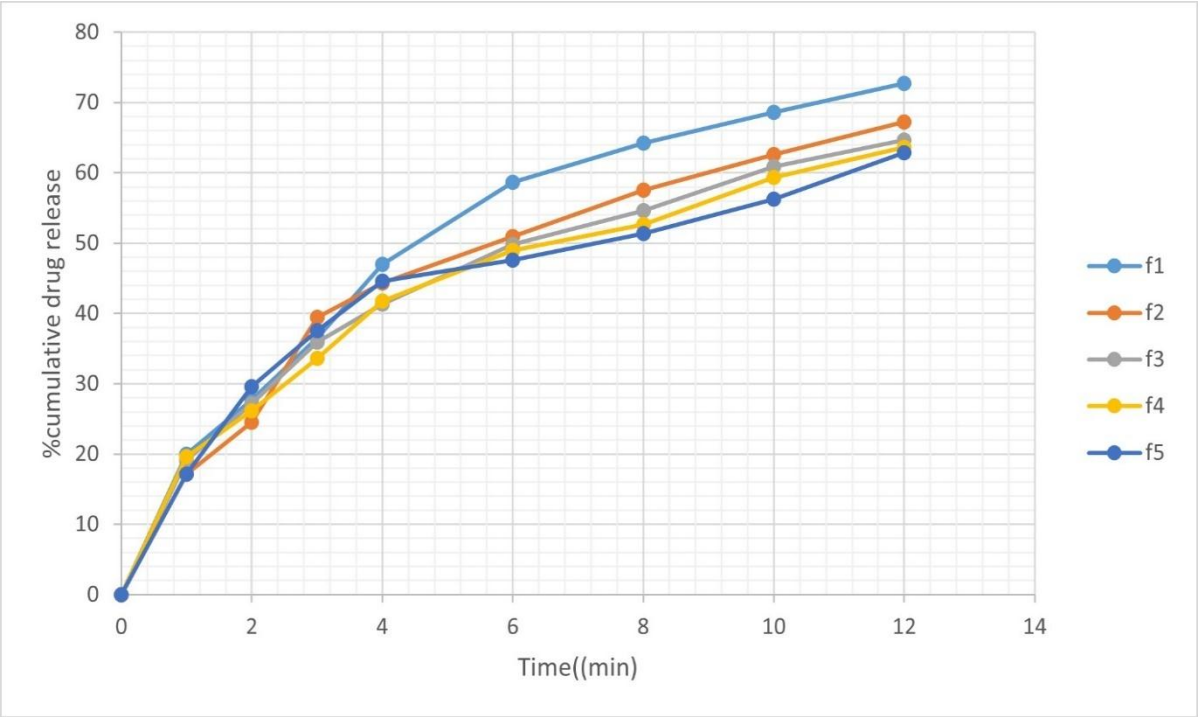

Fig.6: *In-vitro* drug release study of polyherbal gel

UV spectrophotometric method

We also calculated the sun protection factor (SPF) of gel by the method of UV spectrophotometer. SPF stands for mainly UVB rays' range 290-320 nm as a measure of protection; thus, we determined its value within this particular range.

Table.12: Determination of SPF by UV-Spectrophotometric method

Wavelength (nm)	**EE×I**	**F1 EE × I× Abs**	**F2 EE × I× Abs**	**F3 EE × I× Abs**	**F4 EE × I× Abs**	**F5 EE × I× Abs**
290	0.0150	0.06176	0.07125	0.05175	0.06125	0.06155
295	0.0817	0.275523	0.354523	0.285524	0.276522	0.275433
300	0.2874	0.985190	0.984131	0.985191	0.985010	0.984192
305	0.3278	0.967177	0.857157	0.951277	0.957127	0.957127
310	0.1864	0.620053	0.670152	0.630155	0.650013	0.630153
315	0.0837	0.232335	0.324454	0.243445	0.242325	0.232445
320	0.0180	0.05572	0.05273	0.05473	0.05454	0.05562
TOTAL	**1**	**3.197758**	**3.314397**	**3.202072**	**3.226787**	**3.19652**
SPF VALUE		**31.98**	**33.14**	**32.02**	**32.27**	**31.97**

Stability study

The base and all formulations stability were explored under various storage conditions and observed for certain physical properties, colour, appearance and odours (for 30days). The results are reflected in the table below. Formulation showed no major changes in the colour, odour or appearance over 30 days.[24]

Table.13: Stability Study of Polyherbal Gel Formulation

Storage condition						
Duration	**0 days**		**15 days**		**30 days**	
Parameter	**8^0 C**	**14^0 C**	**8^0 C**	**14^0 C**	**8^0 C**	**14^0 C**
Appearance						
F1	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid	Slightly liquid
F2	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid
F3	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid
F4	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid	Slightly liquid
F5	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid
Colour						
F1	Pale green	Pale green	Pale green	Green	Pale green	Pale green
F2	Pale green	Pale green	Pale green	Pale green	Pale green	Pale green
F3	Pale green	Pale green	Pale green	Pale green	Pale green	Light green
F4	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
F5	Pale green	Pale green	Pale green	Pale green	Light green	Light green
Odour						

F1	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic
F2	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic
F3	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic
F4	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
F5	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic

CONCLUSION

Polyherbal sunscreen gel of herbal oils and extract such as *avocado oil, tea tree oil* and *aloe vera extract* was successfully prepared to reduce the use of synthetic formulations that may cause adverse effects in comparison to herbal formulation and to exploits extra therapeutic effect of gel by formulating polyherbal formulation. This polyherbal sunscreen gel evaluated for various parameter like sunscreen activity, colour, odour, pH, homogeneity, extrudability, Spreadability and appearance. The developed polyherbal sunscreen gel was found to be better sunscreen activity against sunburn, pigmentation and photoaging. The sun tends to either be reflected by the herbal extract present in sunscreen gel, or it could be prevented from penetrating to the inner layers of our skin by means of absorbing the sun's UV radiation. From the above study, one can say that herbal sunscreen gel does not have any side effects, it is cheap and it helps in protecting our bodies from dangerous UV rays.

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