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Formulation and Evaluation of Skin Alleviating Suntan SLN Lotion of Herbal Extracts

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Herbal, Antioxidant, SLN, Lotion.

Abstract
Natural plant extracts have recently been regarded as viable sunscreen resources due to their strong UV radiation absorption and antioxidant activity. In order to lessen the risk of skin cancer, herbal suntan lotion works to shield the skin from the sun's ultraviolet rays. This lowers the chance of skin damage. Because it has anti-inflammatory, antioxidant, and wound-healing characteristics, the Carica papaya L. (Caricaceae) and mulberry (Moraceae) extract is beneficial for the skin. The goal is to create an SLN lotion that increases the medicinal effectiveness, bioavailability, and stability of plant ingredients as well as activities such as whitening, acne control, and anti-aging. The melt dispersion ultrasonication method was used to create a solid lipid nanoparticle lotion with Carica papaya and mulberry extracts, and several combinations recommended by the design expert were created. As a result, mulberry and papaya extract can be used to create cosmetic formulations with depigmenting activity. The sunscreen creams were tested for stability, safety, and SPF using three distinct compositions: F1, F2, and F3. The sunscreen lotions were found to be non-mutagenic, non-irritant, stable, and to have SPF for normal skin, and the batch with the best results was compared to the commercial formulation.

Introduction

The sun is a source of both life and energy. However, new research has identified the sun as the primary cause of adverse effects such as sunburn and drug-induced phototoxicity, as well as the chronic dangers of regular sun ray exposure such as sunburn, crack, melanoma and pigmentation, cancer, and immunological suppression. Because of the detrimental effects of UV rays, there is a need to produce sunscreen formulations to heal, prevent sunburn, suntan, skin cancer, and premature skin ageing, as well as to enhance the degree of Sun Protection Factor.

Various formulations have varying sun protection effectiveness based on their UV ray absorption efficacy, but most formulations are expensive and contain synthetic chemicals that have the potential for toxicity and even cancer. As a result, there is a need to create and test effective and safe sunscreen products that can treat sunburn, wounds, cracks, wrinkles, premature ageing, and contain antioxidant components to help guard against the long-term detrimental effects of sunray-mediated free radicals. Herbal extracts provide a healing, softening, regenerating, and sunblock action on these areas. Beneficial phytoconstituents include phenolic acids, flavonoids, and polyphenols with a high molecular weight. Articles for download.[1][2]

Skin-whitening cosmetics are essential for both skin lightening and minimising the appearance of dark spots on the skin. Bioactive chemicals from plants are becoming increasingly appealing for use as cosmetic ingredients in current formulations because they contain vitamins, antioxidants, essential oils, proteins, phenolic compounds, and other active substances. Numerous phenolic compounds and other bioactive compounds have been demonstrated to contain natural antioxidant components, as well as anti-inflammatory, anti-microbial, anti-aging, and tyrosinase-inhibitory capabilities. Furthermore, when compared to synthetic components, these compounds in cosmetic products are safer, biodegradable, less harmful to the environment, and more biologically active.[3]

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The mulberry (Morus alba L.), a member of the Morus genus and Moraceae family, may be found all over the world in both tropical and temperate settings. Mulberry can be found throughout East Asian countries such as Japan, China (particularly the Manchu region), and Mongolia.

Mulberry extract is high in natural antioxidants. The mulberry Morus Alba contains a lot of phenolic chemicals and anthocyanin. Anthocyanins are known to be powerful antioxidants. Anthocyanins, gallic acid, flavonoids, and tannins are the finest cosmetic ingredients for preventing cell damage. Leaves contain fixed oil, carbohydrates, proteins, tannin, alkaloids, flavonoids such as apigenin, quercetin, and rutin, glycosides, and saponins. Apigenin is a flavone. Morus alba ethanol leaf extract contains three flavonol glycosides: quercetin 3- (6malonylglucoside),rutin, and isoquercitrin—are antioxidants.[4][5]

Because of the use of its fruit, leaves, dried leaves, seeds, roots, and stems in traditional medicine, Carica papaya is one of the most well-known plants in the world. The presence of several components such as flavonoids, phenolic compounds, phytosterols, terpenoids, tannins, anthraquinones, cardiac glycosides, saponins, and alkaloids supports the presence of considerable bioactive phytochemicals in the Carica papaya leaf. The carica papaya leaf is beneficial to the skin because it has anti-inflammatory, antioxidant, and wound-healing qualities..[6][7]

Solid Lipid Nanoparticles

Solid lipid nanoparticles (SLN) offer a variety of potential applications in research and drug delivery, and they are at the cutting edge of the rapidly growing field of nanotechnology[8]. Because of their unique size-dependent properties, lipid nanoparticles provide an opportunity to develop innovative therapeutics. The capacity to integrate medications into nanocarriers enables therapeutic targeting, resulting in a new drug delivery strategy. As a result, solid lipid nanoparticles hold significant promise for accomplishing the goal of precise and regulated medicine administration.[9]

Lipid nanoparticle-based cosmetics have received a lot of interest in recent years due to their biocompatibility, safety, and increased functionality. Lipidic nanocargos play an essential part in cosmetic preparations designed to prevent skin disease due to their higher loading and regulated active ingredient release capabilities. Because of their tiny particle size (ranging from 1-100 nm) and high specific surface area by volume, they provide good carrier candidates for active ingredients in cosmetic products. [10] Because of better penetration, regulated drug release, local targeting, and low toxicity, a lipid nanoparticle-based cosmetic or cosmeceutical with an active component load provides a specific function in treating dermatological issues.[11][12][13]

As a result, sunscreen products containing these chemicals can provide the required all-in-one product.

MATERIAL

The plant materials used in the formulation were collected from the whole sale supplier of Herbal Crude Drugs, Amsar Private Limited Indore, India.

Instruments

Instruments used for analysis were pH meter (Euiptroincsc, India), Brookfield viscometer [LVDV 2] spindle], FTIR [Schimadzu], Sonicatior [Lad-Enertech Electronics Pvt Ltd, Vasai]Scanning Electron Microscope[Diyas Lab, Mumbai]HPTLC [Anchrome Enterprise, Mumbai]and UV visible spectrophotometer [UV 1700, Shimadzu, Japan].

Methods

A. PRELIMINARY PHYTOCHEMICAL EVALUATION

Plants' medicinal properties are determined by their phytochemical components. Many regions of plants contain alkaloids, flavonoids, phenolics, tannins, saponins, steroids, glycosides, terpenes, and other important phytochemicals. To isolate phytochemicals from plant ingredients, many extraction procedures might be applied.[14][15] [16]

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B. SOLUBILITY PROFILE OF CARICA PAPAYA

Carica papaya solubility was determined in several solvents such as hexane, ethanol, ethyl acetate, methanol, dichloromethane, and water. [17]

C. DETERMINATION OF WAVELENGTH MAXIMA

Concentration 10ug/ml papaya dissolved in purified water and scanned across a 400-800nm wavelength range.

D. STANDARD CALIBRATION CURVE OF PAPAYA

A UV spectrophotometer was used to capture a standard calibration curve of papaya extract. The UV absorbance of papaya extract was measured using dilutions ranging from (2-10ug/ml). [18]

E. TOTAL PHENOLIC CONTENT

The folin-ciocalteu reagent was used to determine the total phenolic content.. Gallic acid was used as a control solution, with concentrations ranging from 50 to 250 ppm. After reacting the standard with 0.15ml of folin-ciocalteu reagent (1: 1 dilution with water), 0.5 ml of saturated solution of sodium carbonate (20% w/v) was added to the reaction mixture. The absorbance measurements were taken with a UV-VIS spectrophotometer at 720nm and then incubated at room temperature for 15 minutes.[18]

F. TOTAL FLAVANOID CONTENT

The extract and reference were treated with 400ul of methanol, 100ul of sodium acetate (1M), and 100ul of aluminium chloride, respectively. Rutin was utilised as the standard, with concentrations ranging from 10 ppm to 70 ppm. The absorbance measurements were collected at 420nm using a UV-VIS spectrophotometer.[19]

G. ANTOXIDANT ACTIVITY

The DPPH radical scavenging activity of extracts was evaluated using a modified version of Maisarah et al. (2013). In each well plate containing varied quantities of extracts (2,4,6,7,8,10ug/mL), 100 L of DPPH solution was added. For 30 minutes, the mixture was held at room temperature in the dark. Ascorbic acid was utilised as the standard. The absorbance was measured at 517 nm, and the radical scavenging activity was calculated using the equation.[20][21]

$$\% \text{ Inhibition} = \frac{\text{Control Abs} - \text{Sample Abs}}{\text{Control Abs}} \times 100$$

H. CORRELATION STUDY

Both assays were subjected to total flavonoid concentration, total phenolic content, and antioxidant activity investigations. [22][23]

I. HPTLC

For the supplied material, fingerprinting analysis was done. Following development, photo documentation was completed in R white, R 254nm, and R 366 nm. The plate is then derivatised with Vanilin Sulphuric acid reagent and heated at 110°C for 3 minutes. Following the derivatisation, photo documentation and scanning are performed at R White and R 366nm. [24][25][26]

Table No 1: Parameters For HPTLC

SR NO	PARAMETER	DESCRIPTION
1	Software	Server Labserver, Version 3.1.21109.3
2	Stationary Phase	TLC Al Plates Silica Gel F254
3	Plate Format	100x100 mm
4	Mobile Phase	Toluene: Ethyl Acetate : Methanol (4:4:1 v/v/v)
5	Lamp	Deuterium and Tungsten
6	Saturation Time	20 min
7	Scanner Type	Multiple ƛ

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J. FTIR STUDIES

To characterise the probable interaction between the medicine and the excipient, Fourier Transform Infrared Spectroscopy was used. It was captured using an FT-IR spectrophotometer. The spectra were scanned in the 4000 - 400 cm-Hz frequency range. [27]

K. SOLID LIPID NANOPARTICLE PREPARATION

Different methods were tried for the preparation of solid lipid nanoparticle. [28]

HIGH SHEAR HOMOGENIZATION

The initial stage in producing the SLN mulberry root extract was to heat glyceryl monostearate to 85°C. Mulberry root extract, distilled water, lecithin, and Tween 80 solution were also heated to 85 °C. Following the addition of the hot water phase to the lipid phase, the mixture was homogenised at high speed for 15 minutes before being sonicated for 15 minutes.

MELT DISPERSION ULTRASONICATION METHOD

Lipid and medicines are melted together at 750 degrees Celsius. The aqueous phase of surfactants in double distilled water is kept at 750°C. The oil phase is mixed with the aqueous phase. Both stages should be combined for 10 minutes with agitation at 600 rpm. Under mechanical churning, a warm microemulsion is diluted in cold water. The resulting microemulsion is ultrasonically treated for 10 minutes to generate SLN.[29]

The method which gave best result was selected for preparation .

L. EVALUATION OF SLN[30]

1. Sizing of the particle

Using fesem, the sln was characterised by determined particle size. Field emission scanning electron spectroscopy was used to determine the mean diameter of the slns in the dispersion. Scanning electron microscopy was used to examine the surface morphology of sln.

2. Efficiency of entrapment

The centrifugation method was used to measure the entrapment effectiveness of sln dispersion. To collect the supernatant liquid, an sln dispersion (containing 5 mg of medication) was centrifuged at 20000 rpm for one hour in a chilled centrifuge. After an appropriate dilution with new phosphate buffer saline ph 7.4, the recovered liquid was filtered to determine the free drug concentration. The absorbance was measured in a uv spectrophotometer at 420 nm and the entrapment efficiency was calculated using the following formula:

Entrapment efficiency = initial conc- Final Conc / Initial Conc * 100

M. DEVELOPMENT OF SLN LOTION CONTAINING CARICA PAPAYA AND MULBERRY EXTRACTS

Formulation Table for lotion containing solid lipid nanoparticle

Procedure

Melting stearic acid, cetyl alcohol, triethanolamine, methylparaben, propylparaben, glyceryl monostearate, and lanolin yielded the oil phase. The second stage, the water phase, was created by dissolving glycerin in distilled water that had been heated to 70°C. The oil phase was gently added to the liquid phase and homogenised using a homogenizer at 750 rpm, following which the SLN extract of mulberry and papaya was added and the speed increased to 3000 rpm to obtain a homogenous suspension.

For providing batches with varying percentages of tween 80, stearic acid, and glyceryl mono stearate, design expert software is employed.

N. EVALUATION OF SOLID LIPID NANOPARTICLE LOTION[31]

The following parameters were examined in 13 batches received from design expert software.

1. Organoleptic Properties:

The appearance of the lotion was examined.

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2.Foreign particle presence:

Lotion was applied to a clean glass slide and viewed against the light.

3. PH:

The PH metre was calibrated using a standard buffer solution. 1 gramme of lotion was dissolved in 50 ml of distilled water, and the lotion's ph was determined.

4. Viscosity:
The formulation's viscosity was evaluated using a Brookfield viscometer (Spindle no 4)

5. Spreadability: The lotion's spreadability was tested using a glass slide instrument.

6. Drug Diffusion in Vitro

The drug release was measured using a treated cellophane membrane attached on one end of a franz diffusion cell open tube containing SLN in lotion.

The dialysis tube held 250 mL of phosphate buffer 6.8. The solution was agitated at 100 rpm with a magnetic stirrer at 370 C, and then 1 ml samples were extracted at 30 minute intervals for 5 hours, and matching amounts of fresh PBS were put in. The samples were filtered, diluted, and UV examined. [32]

7. Stability Investigations

Stability experiments were conducted for formulations with high entrapment efficiency by storing the formulations at two different temperatures, 4°C and 25 2°C, and the drug content was evaluated after 30 days to detect any change in the SLN's entrapment efficiency.[33]

8. Microbiological Investigations

The created lotion was streak plate inoculated on agar media plates, and a control was prepared by excluding the lotion. The plates were placed in the incubator and incubated at 37°C for 24 hours. After the incubation period, the plates were removed and compared to the control for microbial growth.

Result And Discussion

A PRELIMINARY PHYTOCHEMICAL EVALUATION

Test for identification of phytoconstituents
In Carica Papaya Extract

Table No. 2

Sr No	Phytochemicals	Observation	Inference
1	Alkaloid	Orange Red Ppt	+
2	Flavanoid	Red Color	+
3	Glycoside	Brick Red Ppt	+
4	Reducing Sugar	Brick Red Ppt	+
5	Saponin	Persistent froth for 15 min	+
6	Steroid	Brown ring at the interface of the two liquids	+
7	Tannin	Green – Black Color	+

B SOLUBILITY OF CARICA PAPAYA

It was found to be soluble in Water , Ethanol , Methanol

C DETERMINATION OF WAVELENGTH MAXIMA

The Concentration 10ug/ml of papaya dissolved in distilled water and scanned over a wavelength range

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of 400 to 800nm and wavelength maxima was found to be 420 nm.

R^2 value was found to be 0.991 and linear graph was obtained with the slope of 0.095.

D STANDARD CALIBRATION CURVE OF PAPAYA

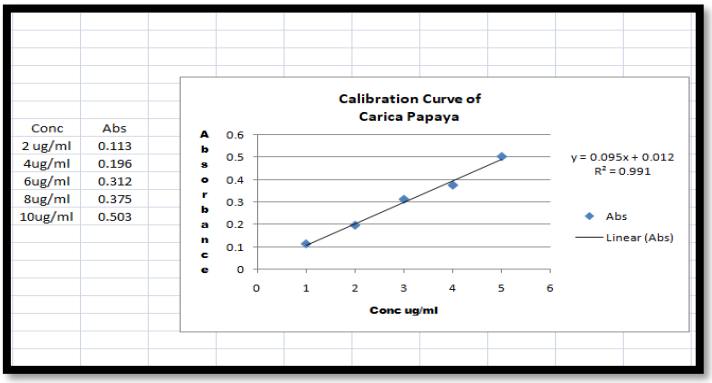

Figure No 1 : Calibration Curve For Carica Papaya

E TOTAL PHENOLIC CONTENT

Figure No 2: Dilutions of Gallic acid Std

Total Phenolic Content in papaya extract was found to be 59.4 mg/g GAE

F TOTAL FLAVANOID CONTENT

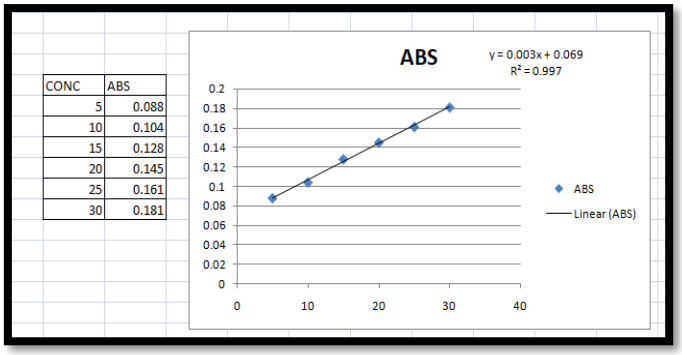

Figure No 3: Calibration Curve for Rutin Std

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Total Flavanoid Content was found to be 93mg/gm rutin equivalent

G ANTIOXIDANT ACTIVITY

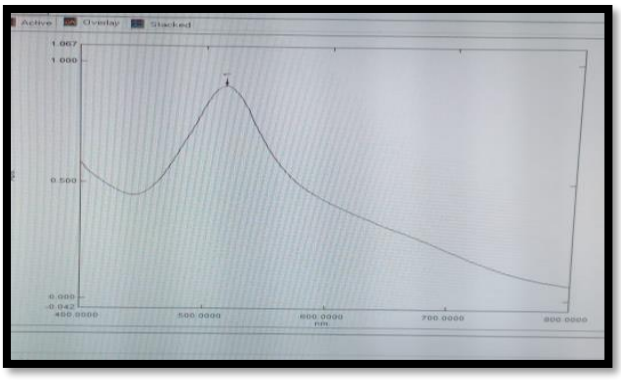

Figure No 4: Std Stock (Ascorbic Acid) UV Graph

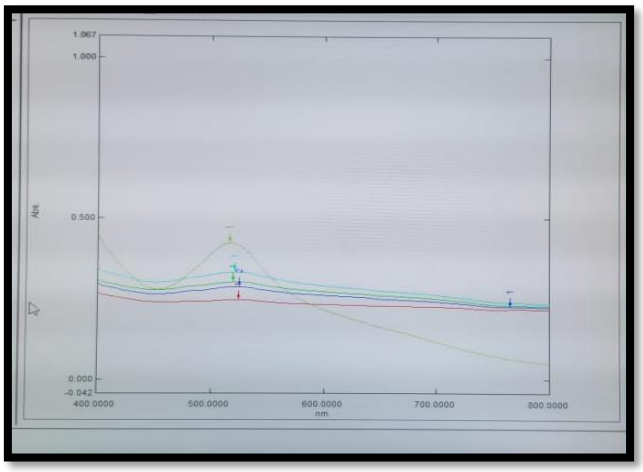

Figure No 5: Papaya Extract Antioxidant Acitivity Uv Graph

SAMPLE CONC	SAMPLE ABS	% INHIBITION
2ug/ml	0.247	72%
4ug/ml	0.286	68.39%
6ug/ml	0.301	66.74%
8ug/ml	0.316	65.08%
10ug/ml	0.332	63.31%

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H HPTLC :

Image At R White

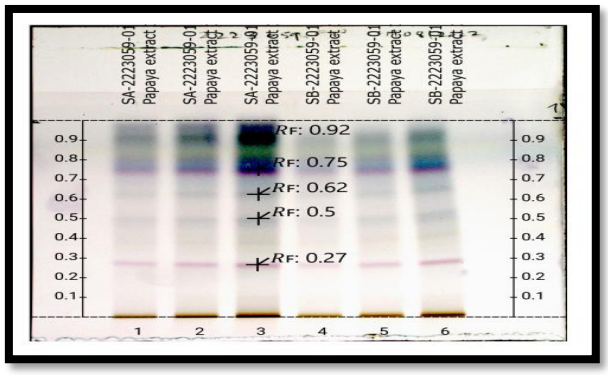

Figure No 6 : HPTLC of Carica Papaya Extract image at R White

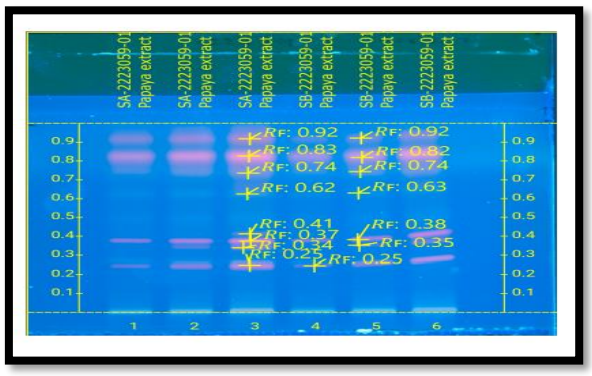

Figure No 7 : HPTLC of Carica Papaya Extract image at 366 nm

SAMPLE : 4ul

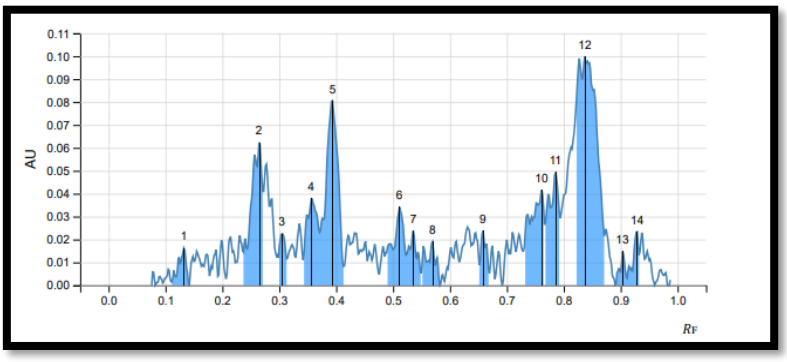

Figure No .8 : HPTLC of Carica Papaya Extract image at 366 nm

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Table No 3. Rf value Obtained from HPTLC For Sample Vol 4ul

Peak #	Start		Max			End		Area		Manual peak
	R_F	H	R_F	H	%	R_F	H	A	%	
1	0.111	0.0015	0.132	0.0162	2.96	0.140	0.0003	0.00025	1.93	No
2	0.237	0.0146	0.265	0.0623	11.36	0.271	0.0410	0.00135	10.38	No
3	0.298	0.0120	0.305	0.0225	4.10	0.313	0.0116	0.00027	2.11	No
4	0.342	0.0111	0.356	0.0378	6.88	0.371	0.0232	0.00085	6.58	No
5	0.371	0.0232	0.394	0.0806	14.68	0.413	0.0083	0.00201	15.48	No
6	0.489	0.0143	0.511	0.0341	6.22	0.523	0.0132	0.00074	5.73	No
7	0.523	0.0132	0.535	0.0238	4.33	0.548	0.0052	0.00040	3.08	No
8	0.550	0.0062	0.569	0.0190	3.47	0.582	0.0000	0.00038	2.90	No
9	0.652	0.0089	0.658	0.0238	4.33	0.668	0.0069	0.00027	2.07	No
10	0.731	0.0165	0.761	0.0416	7.57	0.766	0.0265	0.00113	8.71	No
11	0.768	0.0276	0.785	0.0493	8.98	0.794	0.0294	0.00099	7.60	No
12	0.821	0.0759	0.837	0.1000	18.21	0.871	0.0216	0.00394	30.31	No
13	0.890	0.0000	0.903	0.0147	2.68	0.910	0.0038	0.00014	1.09	No
14	0.911	0.0031	0.929	0.0234	4.25	0.932	0.0132	0.00026	2.04	No

SAMPLE 10 ul

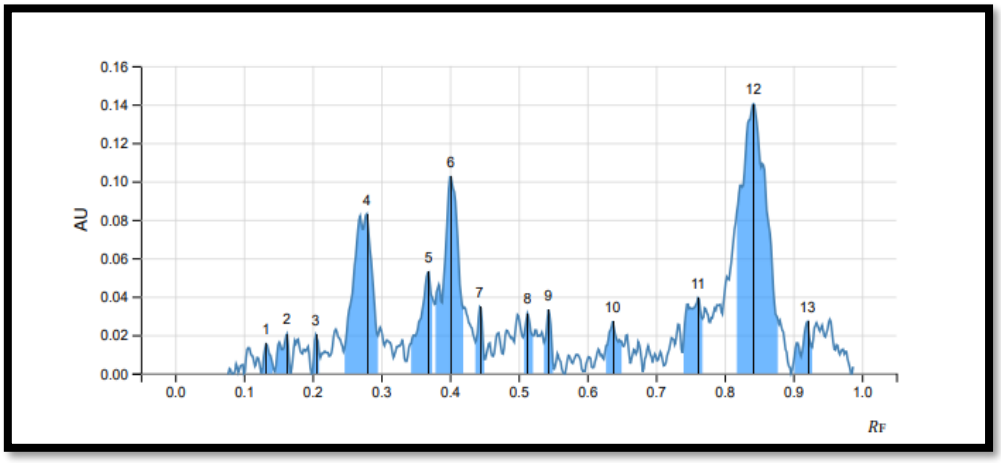

Figure No 9: HPTLC of Carica Papaya Extract image at 366 nm

Table No 4 Rf value Obtained from HPTLC For Sample Vol 10ul

Peak #	Start		Max			End		Area		Manual peak
	R_F	H	R_F	H	%	R_F	H	A	%	
1	0.126	0.0000	0.132	0.0153	2.44	0.144	0.0019	0.00016	1.01	No
2	0.145	0.0009	0.163	0.0205	3.27	0.168	0.0000	0.00028	1.79	No
3	0.198	0.0000	0.205	0.0199	3.18	0.211	0.0082	0.00015	0.96	No
4	0.245	0.0115	0.279	0.0829	13.25	0.295	0.0197	0.00264	16.73	No
5	0.342	0.0152	0.369	0.0527	8.42	0.376	0.0381	0.00111	7.02	No
6	0.377	0.0360	0.402	0.1023	16.33	0.419	0.0340	0.00266	16.90	No
7	0.437	0.0164	0.444	0.0345	5.52	0.450	0.0074	0.00031	1.96	No
8	0.506	0.0188	0.513	0.0311	4.97	0.521	0.0197	0.00035	2.25	No
9	0.537	0.0161	0.544	0.0332	5.31	0.552	0.0020	0.00030	1.90	No
10	0.624	0.0074	0.637	0.0272	4.34	0.652	0.0145	0.00050	3.19	No
11	0.739	0.0108	0.761	0.0393	6.28	0.768	0.0285	0.00094	5.96	No
12	0.818	0.0838	0.842	0.1402	22.40	0.879	0.0259	0.00593	37.57	No
13	0.900	0.0052	0.921	0.0269	4.30	0.927	0.0136	0.00044	2.78	No

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I_FTIR

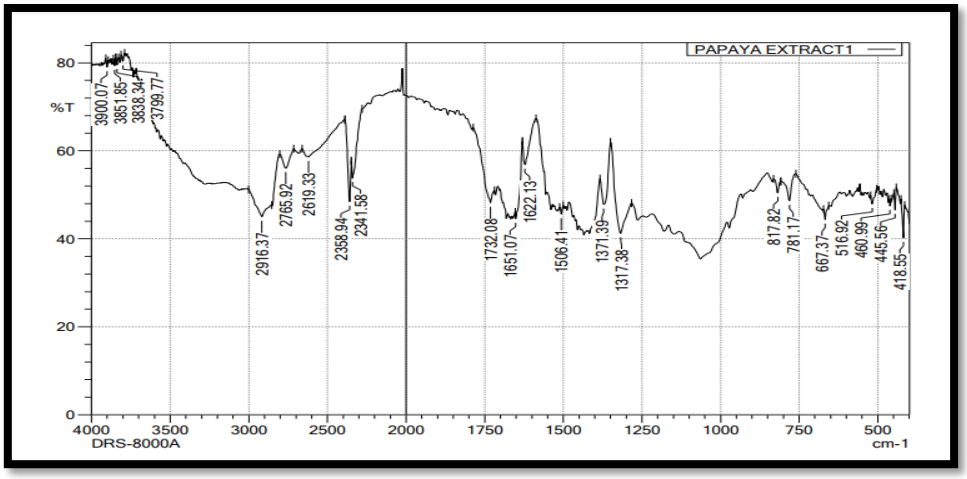

Figure No 10 : FTIR of Carica Papaya Extract

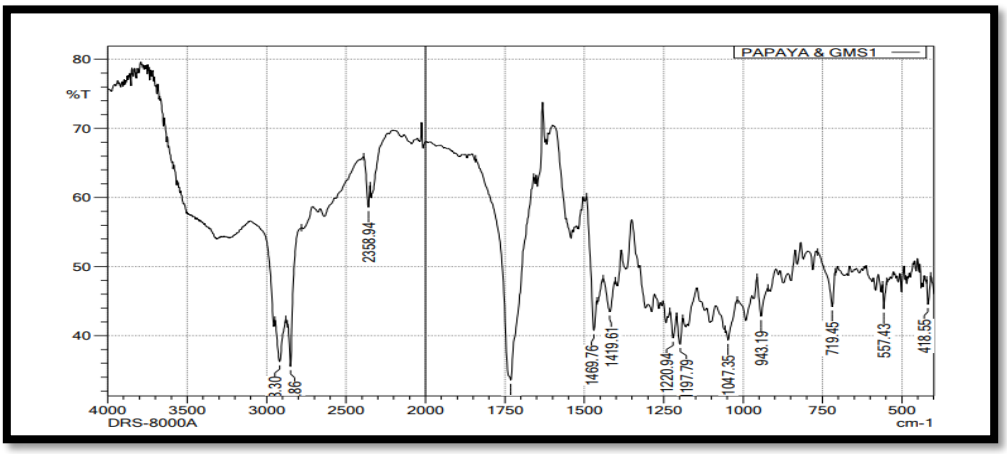

Figure No 11: FTIR of Carica Papaya Extract and GMS

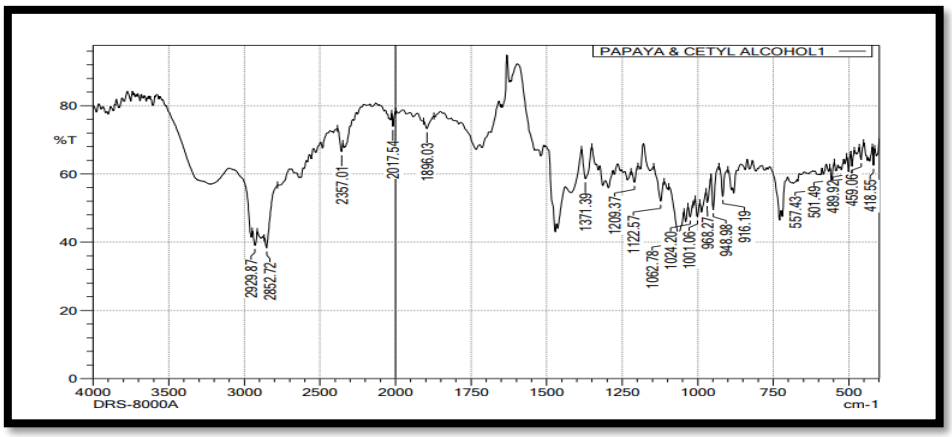

Figure No 12: FTIR of Carica Papaya Extract and Cetyl Alcohol

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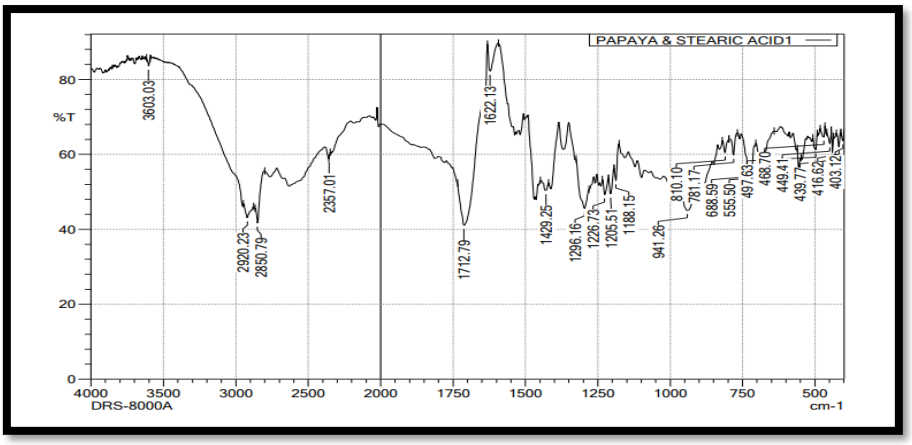

Figure No 13: FTIR of Carica Papaya Extract and Stearic Acid

FTIR Spectroscopy was used to confirm the interaction between the drug and the excipients

J Solid lipid nanoparticles preparation

Melt dispersion ultrasonication method was chosen for preparation of solid lipid nanoparticles .

K Evaluation Of SLN

Particle Size

Table No 5 : Particle Size And Entrapment Efficiency

BATCHES	ENTRAPMENT EFFICIENCY	PARTICLE SIZE
F1	75.36 %	13.88 um
F2	56.18%	8.32 um
F3	34.55 %	3.00 um
F4	55.99 %	10.00 um
F5	75.12 %	14.00 um
F6	35.81 %	3.00 um
F7	55.02 %	2.00 um
F8	55.69 %	8.50 um
F9	54.67 %	14.50 um
F10	72.88 %	20.00 um
F11	71.97 %	8.00 um
F12	56.05 %	14.50 um
F13	54.74 %	3.00 um

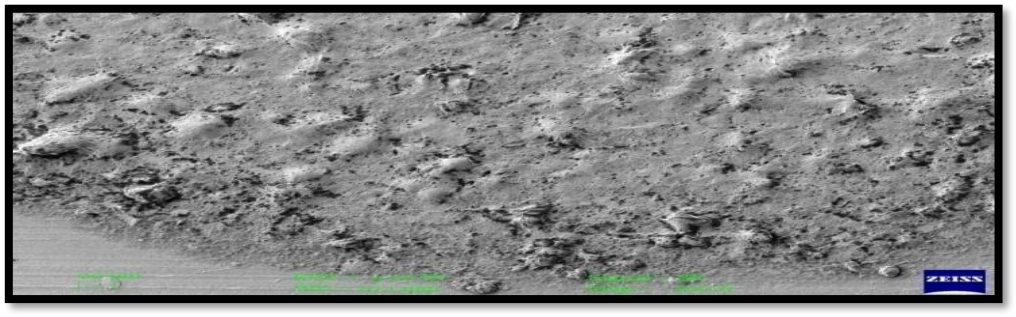

Figure No 14: FESEM of Nanoemulsion Batch F1

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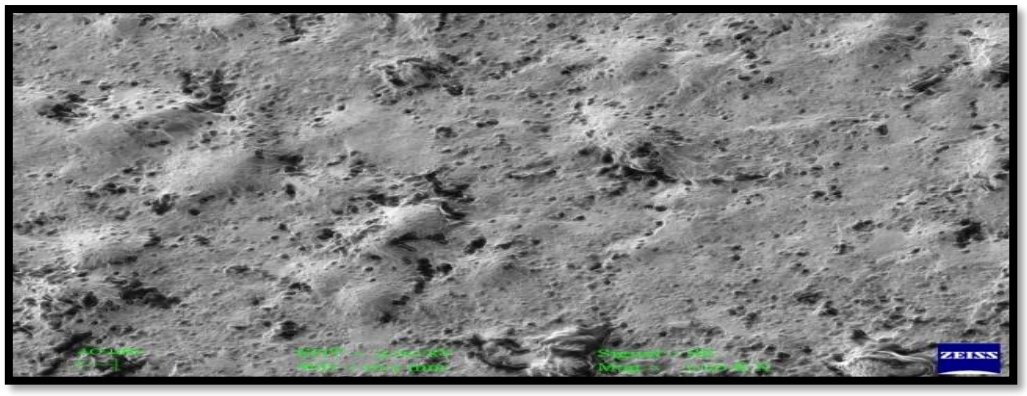

Figure No 15: FESEM of Nanoemulsion Batch F4

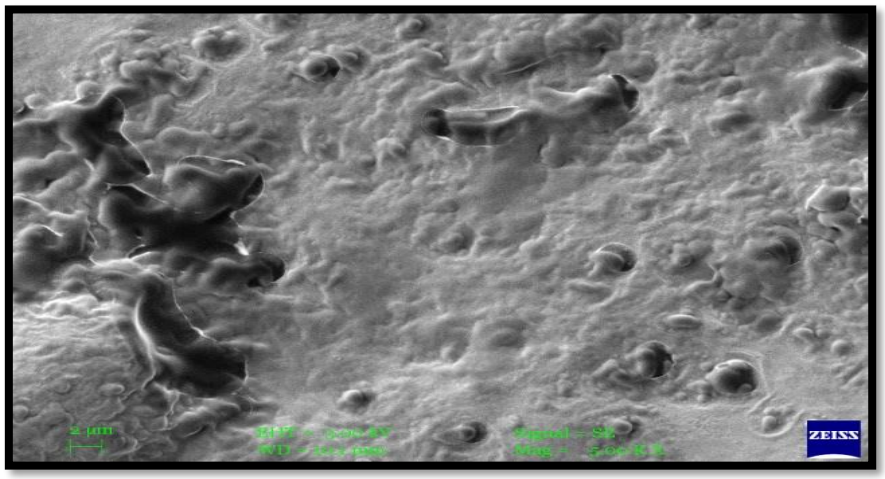

Figure No 16: FESEM of Nanoemulsion Batch F7

Table No 6: Anova for Particle Size

Response 1: PARTICLE SIZE

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	341.78	3	113.93	5463.98	< 0.0001	significant
A-GMS	340.46	1	340.46	16328.75	< 0.0001	
B-TWEEN 80	0.5513	1	0.5513	26.44	0.0006	
C-STEARIC ACID	0.0623	1	0.0623	2.99	0.1180	
Residual	0.1877	9	0.0209			
Cor Total	341.97	12				

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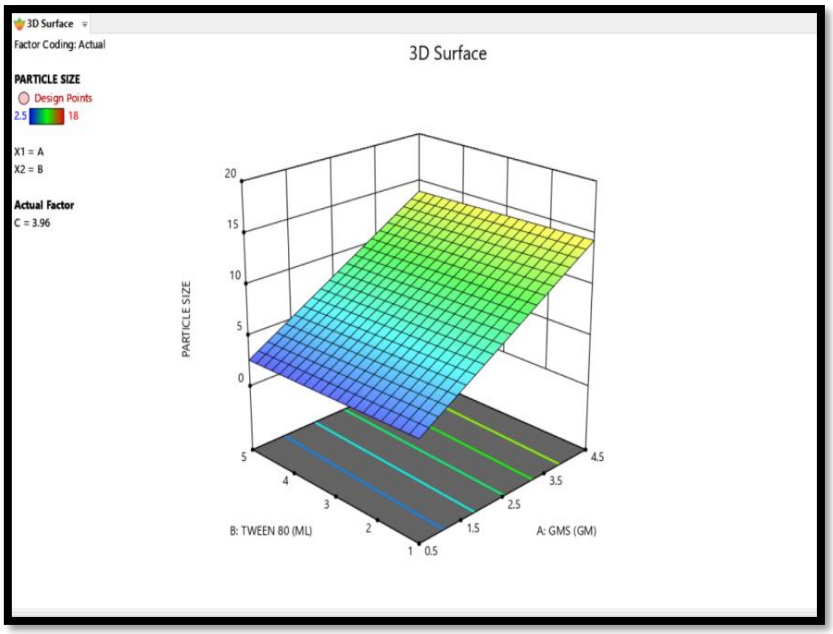

Figure No 17: 3D Surface Graph for Particle Size

L ENTRAPMENT EFFICIENCY

Table No 7: Anova for Entrapment Efficiency

ANOVA for Linear model

Response 2: Entrapment Efficiency

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	2098.12	3	699.37	2730.41	< 0.0001	significant
A-GMS	1103.86	1	1103.86	4309.58	< 0.0001	
B-TWEEN 80	1036.00	1	1036.00	4044.62	< 0.0001	
C-STEARIC ACID	1.16	1	1.16	4.53	0.0621	
Residual	2.31	9	0.2561			
Cor Total	2100.43	12				

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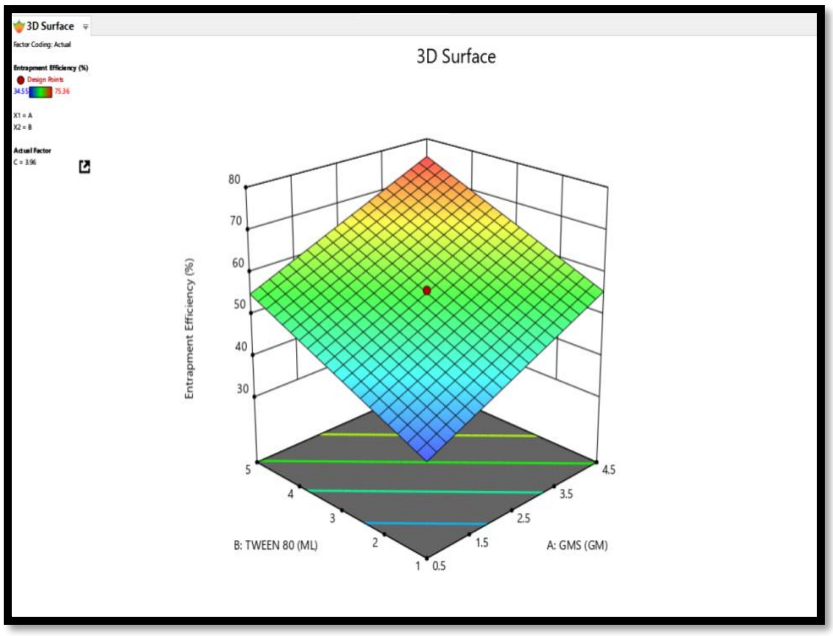

Fig No 18 : 3D Surface Graph for Entrapment Efficiency

M Formulation Of SLN Lotion

Design Expert Version 13 was used to obtain batches . Response surface and central composite were the study types used . 13 batches were obtained from the study type with different concentration of gms , stearic acid and tween 80 and all the batches were evaluated.

N Evaluation of SLN Lotion

Organoleptic Properties : Solid Lipid Nanoparticle Lotion containing herbal extracts was Pale Yellow in color with pleasant odor .

Presence of Foreign Particles : Lotion was free from any foreign particles and grittiness.

PH : The optimal pH value of skin on most of our face and body lies between 4.7 and 5.75. The pH of 7 (clean water) is considered neutral. Anything below it is acidic, and anything above it is alkaline, so the skin's normal pH is somewhat acidic. PH of the lotion was found to be in the range of 5-6.5 which is in acceptable range.

Viscosity : Viscosity is a property that reveals a material's thickness and flowability. In terms of science, viscosity is a measurement of a fluid's internal flow resistance. Conditions in the surrounding area, like as temperature and pressure, have an impact on viscosity. Viscosity of the Lotion was found in the range of 6000 to 10,000 cps.

Table 8. Evaluation of Lotion

SR NO	BATCHES	APPEARANCE	PH	SPREADABILITY	VISCOSITY	In Vitro Diff
1	F1	WHITE	5.4	11.05gmcm/sec	6990CPS	78.96 %
2	F2	WHITE	5.6	12.88 gmcm/sec	6460 CPS	59.40 %
3	F3	WHITE	5.8	6.82 gmcm/sec	9086CPS	36.89 %
4	F4	WHITE	5.5	8.88gmcm/sec	8045 CPS	56.89 %
5	F5	WHITE	5.4	7gmcm/sec	8879CPS	79.58 %

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6	F6	WHITE	5.9	11.07 gmcm/sec	7201CPS	37.52 %
7	F7	WHITE	5.7	10.34 gmcm/sec	7739CPS	58.88 %
8	F8	WHITE	5.2	5.18 gmcm/sec	9630CPS	59.68 %
9	F9	WHITE	5.5	7 gmcm/sec	8349CPS	57.52 %
10	F10	WHITE	5.5	9.16 gmcm/sec	7419CPS	78.12 %
11	F11	WHITE	5.8	9 gmcm/sec	8434CPS	75.48 %
12	F12	WHITE	6.0	11.28 gmcm/sec	6470CPS	57.83 %
13	F13	WHITE	5.4	6.5 gmcm/sec	9620CPS	53.20 %

Table No. 9: Anova for Viscosity

ANOVA for Linear model

Response 5: VISCOSITY

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	1.431E+07	3	4.771E+06	20232.92	< 0.0001	significant
A-GMS	1.448E+06	1	1.448E+06	6140.67	< 0.0001	
B-TWEEN 80	7.023E+05	1	7.023E+05	2978.44	< 0.0001	
C-STEARIC ACID	1.212E+07	1	1.212E+07	51400.28	< 0.0001	
Residual	2122.10	9	235.79			
Cor Total	1.431E+07	12				

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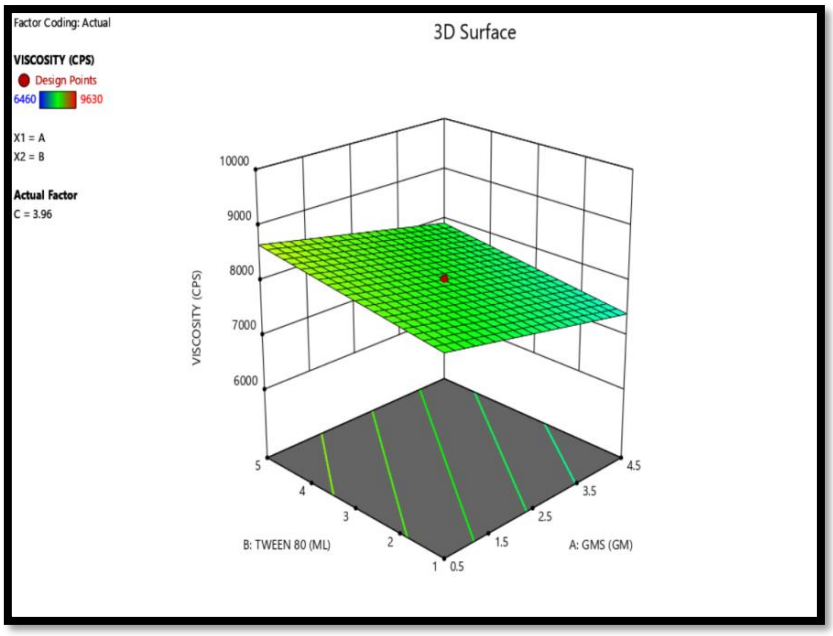

Figure No 19: 3D Surface Graph for Viscosity

O Spreadability

Table No. 10: Anova for Spreadability

ANOVA for Linear model

Response 3: SPREADABILITY

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	63.65	3	21.22	411.64	< 0.0001	significant
A-GMS	0.3596	1	0.3596	6.98	0.0269	
B-TWEEN 80	0.1209	1	0.1209	2.34	0.1601	
C-STEARIC ACID	63.16	1	63.16	1225.43	< 0.0001	
Residual	0.4639	9	0.0515			
Cor Total	64.12	12				

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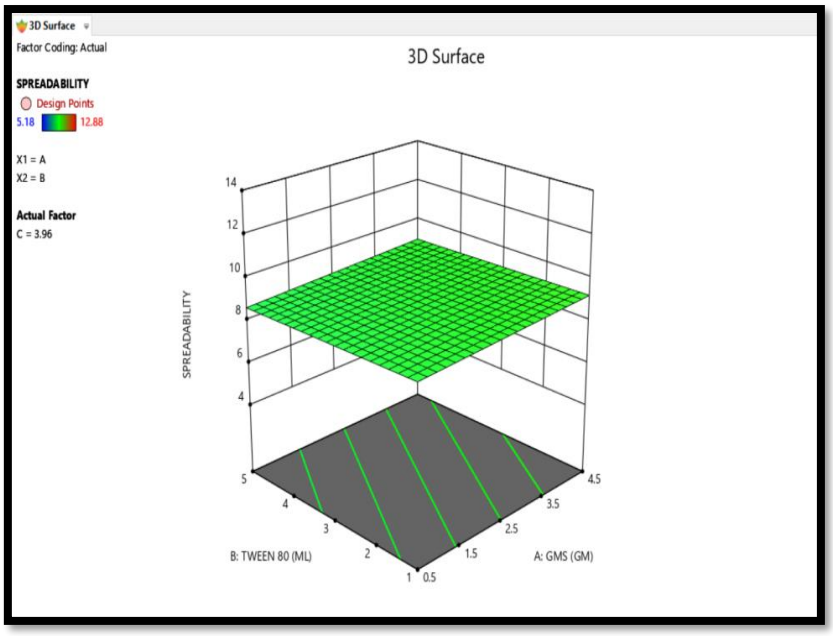

Figure No 20: 3D Surface Graph for Spreadability

P In Vitro Diffusion

Table No. 11: Anova for In Vitro Diffusion

ANOVA for Linear model

Response 4: INVITRO DIFFUSION

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	2127.57	3	709.19	1537.06	< 0.0001	significant
A-GMS	1120.75	1	1120.75	2429.04	< 0.0001	
B-TWEEN 80	1045.03	1	1045.03	2264.93	< 0.0001	
C-STEARIC ACID	5.21	1	5.21	11.29	0.0084	
Residual	4.15	9	0.4614			
Cor Total	2131.72	12				

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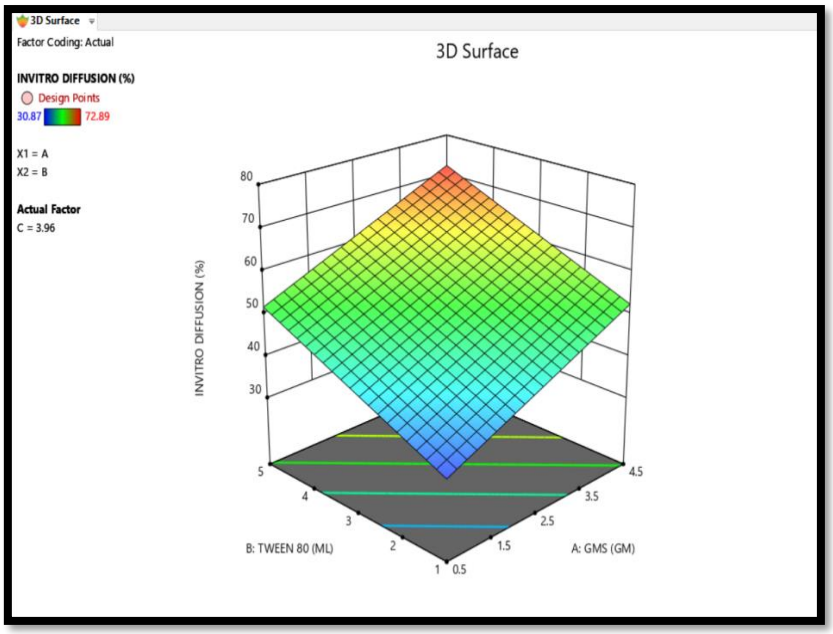

Figure No 21: 3D Surface Graph for In Vitro Diffusion

Q Stability Studies

Table No 12: Stability Studies

BATCHES	IMMEDIATELY AFTER PREPARATION	AFTER 30 DAYS	
		4^0C	25^OC
F1	78.96 %	78.1%	76.2
F2	64.23%	63.22	62.34
F3	38.14 %	38.01	37.99
F4	61.39 %	61.22	60.73
F5	77.45 %	77.36	76.78
F6	40.86 %	40.10	39.26
F7	44.35 %	43.96	42.00
F8	66.41 %	65.78	63.28
F9	48.22 %	47.99	45.88
F10	69.88 %	69.02	68.84
F11	80.38 %	79.99	78.23
F12	48.89 %	48.74	46.08
F13	43.65 %	42.77	42.07

R Microbial Studies

After the incubation period, plates were taken out and no microbial growth was found .

F1 BATCH WAS SELECTED FROM ALL THE BATCHES AND SUN PROTECTION ACTIVITY WAS CARRIED OUT FOR THE OPTIMIZED BATCH

SPF of the extract was calculated using the Mansur equation and a UV-visible spectrophotometer (HALO DB-20). Using a spectrophotometer, the absorbance was measured at wavelengths between 290 and 320 nm, and the SPF was calculated by using the Mansur equation.

SPF = CF x 290Σ 320EE (λ) x I (λ) x Abs (λ

Where EE is for erythemal effect spectrum, I stands for solar intensity spectrum, Abs stands for sunscreen

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product absorbance, and CF stands for correction factor (=10).

Table No 13: Sun Protection Factor

WAVELENGTH	EE(λ) x I(λ)	F1 (ABSORBANCE)	EE(λ) x I x F1
290	0.015	1.98	0.0297
295	0.0187	2.25	0.0420
300	0.2874	1.85	0.5316
305	0.3278	1.62	0.5310
310	0.1864	1.28	0.2385
315	0.0839	1.14	0.0956
320	0.0180	0.986	0.0177
			∑ = 1.4861
SPF=CF x 1.4861			1.4861 x 10 = 14.86

S COMPARATIVE STUDY

Comparison study was done between the solid lipid nanoparticle lotion , Lotion without nanoparticles , and marketed formulation

Table No 14: Comparative Study

PARAMETERS	SLN LOTION	LOTION	MARKETED FORMULATION
PH	5.4	4.7	5.5
In Vitro Diffusion	78.96%	52.68 %	58.72%
Spreadability	11.05gmcm/sec	8 gmcm/sec	18 gmcm/sec
SPF	14.8	9.6	6

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Figure No 22 Comparative Study Of Lotion

Conclusion

Solid lipid nanoparticle lotion was formulated using carica papaya and mulberry extracts by using melt dispersion ultrasonication method , various combinations suggested by design expert were formulated. Characterization of extract was done and Papaya and mulberry extract showed good TPC and TFC activity which results in good tyrosinase inhibition activity thus , mulberry and papaya extract can be used to formulate cosmetic formulations with dipigmenting activity . All the 13 batches resulting from design expert were evaluated on the basis of various parameters like diffusion profiles , spreadability , entrapment efficiency and the batch which showed better results was compared with marketed formulation . Thus it can be concluded that formulating herbal extracts in the form of SLN lotion resulted in better entrapment efficiency , stablility , permeability as compared with the Extract lotion and marketed formulation . The natural substance could become an excellent, affordable, and readily available formulation ingredient in skin whitening products in addition to their many beneficial advantages and safety.

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