# Development and Formulation of a Topical Preparation with Povidone-Iodine Nanoparticles for Wound Healing

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## ABSTRACT

It damages the microbial cell growth of the protein and nucleic acid and their structure and sy nthesis. There are different type of formulation of povidone-Iodine are current in the market like scrub, ointment, solution like that .the nanoparticle (solid lipid nanoparticle) formulated gel preparation of the Povidone -Iodine have better result in wound healing. At topical use, the nanoparticle has several benefits. Due to their distinct desired impacts on t he skin, solid lipid nanoparticles (SLN) have very appealing colloidal carrier structures for sk in use... Research on solid lipid nanoparticles suggests that this approach may find application as a drug delivery system for hydrophilic actives, offering enhanced drug entrapment effectiveness and regulated drug release.

The topical preparation such as gel formulations provides an appropriate delivery system for drugs as they are not as greasy and can readily be separated from the skin. Advantages of This Route It provide a largest surface area.

**Conclusion-**

Povidone-Iodine having better result as a wound healing .when we incorporate Povidone-Iodine solid lipid nanoparticle into gel it having better topical response good permeation and controlled release of drug and having better result in wound healing

## INTRODUCTION

Healing of wound is a formation of new tissue by different molecular Sequence and cellular trial is produce when damage tissue repair are restore.. The Phenomenon occur after the injury to the improvement of edema of tissue is known as exsudative Phenomenon. The stage in which the area of the injury is reduced is known as Proliferative stage it work by contracting of myofibroblasts and fibroplasias. In this phase, the angiogenesis and there epithelialization procedures are watched. Endothelial cells can separate into mesenchymal segment, and this distinction has all the earmarks of being finely coordinated by a gathering or set of flagging proteins which are examined in the writing This is called as Hedgehog.

TYPE OF WOUND

- ✓ Acute wound
- ✓ Chronic wound
- ✓ Complicated wound

**ACUTE WOUND**

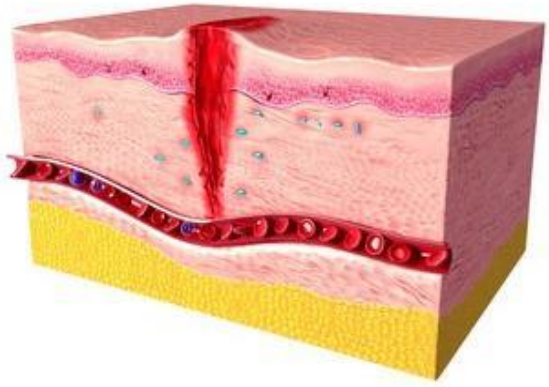
Wounds which are heal it selves and those takings normally by following suitable and also as orderly on healing pathways, with the ends answer of both useful. The period way of recuperating or treatment is ordinarily going from the 5 to 10 days or inside the 30 days .And anatomical re-establishment, is classify as acute wounds.

**CHRONIC WOUND**

The healing procedure is incomplete and disturbed by the various factors depends the wound healing. These factors include Illness of the injury cause by injury, tissue hypoxia of the injury, necrosis About the wound, exudates and abundance dimensions of provocative cytokines release. Chronic wounds may cause from different causes, including like naturopathic, pressure effect, arterial and venous absence cause chronic wound formation, burns and vasculitis of the wound

**COMPLICATED WOUND**

This injury is a unique existence and is called as a mix of a contamination and a tissue deformity wound. Infection poses a constant threat to heal the wound main reason of the imperfection, in contrast, evolves owing to the post-infectious, or an open tissue resection.



**NANOTECHNOLOGY AND SOLID LIPID NANOPARTICLE**

**Nanoparticle**

A nanoparticle is a particle with a size that falls somewhere between one and one hundred nanometers, including the interfacial layer. The majority of the properties of nanoscale matter are impacted by the interfacial layer, which is an extremely important component.Interfacial layer normally includes particles, inorganic and characteristic molecules. Stabilizers are regarded as natural atoms that cover inorganic nanoparticles,surface ligands an d toppings, or passivating experts. A molecule is defined in nanotechnology as a small entity that functions as a whole in terms of both its vehicle and its characteristics. The diameter of particles further divides them into classes.

**Advantage**

- It Enhanced solubility
- It improved oral bioavailability
- It improved rate of dissolution
- It bigger surface area
- For that a smaller dose required.
- The therapeutic intervention starts more quickly

**SOLID LIPID NANOPARTICLES**

Since its introduction in 1991, solid lipid nanoparticles (SLNs) have served as a substitute for conventional colloidal carriers such as emulsions, liposomes, and polymeric smaller-scale nanoparticles.

As a novel colloidal instruction transporter for intravenous applications, nanoparticles are dev eloped using solid lipids as expected as an elective particulate conveyor carrier. Solid lipid nanoparticle are sub-micron colloidal carrier extend from the range of 50-1000 nm, which is complete away of physiological lipid which spotted in water or in a fluid surfactant arrangement. SLN offers one of kind properties like as little size, having a huge surface zone. One of the innovative potential colloidal carriers is SLNs. Systems are optional components of polymers that are identical to oil in water emulsion for parenteral nutrition. Their numerous advantages include being highly biocompatible, having a low lethality, and having lipophilic drugs that are better delivered by the system and physically stable, robust lipid nanoparticles.

**Advantages of SLN**

• Targeted release system
• It is highly biocompatible.
• It also gets better stability of pharmaceuticals products
• It has High and better drug content.
•It is easy to balance up and disinfect.
• It Improved control of the release of encapsulated compounds.
• It improved the bioavailability of the entrap bioactive compounds.
• These are much easy to produce than biopolymer nanoparticle.
• There are no any special solvent required.
• The predictable emulsion developed method relevant.
• The raw resource necessary the same as in emulsions.
• Very elevated long-standing stability.
• Application versatility.

**Disadvantages of SLN**

• The Particle growth.
• The Unpredictable gelatin affinity.
• The unpredicted dynamics of the polymeric transition.

# MATERIAL AND METHOD

## METHOD EMPLOYED FOR POVIDONE IODINE

### Physiochemical Characterization

We received a complimentary sample of Povidon-Iodine from Infinium Pharmachem Pvt. Ltd. in Vallabh Vidhyanagar, Gujrat, India. The following criteria were used to determine the obtained drug sample's physicochemical characteristics.

### Organoleptic properties evaluation

Color and taste, among other organoleptic characteristics, were assessed.

### Melting point determination

Using a capillary melting point equipment, the povidone-iodine melting point was ascertained..

### Assay of the Povidone-Iodine

PROCEDURE

Weigh precisely three grams of povidone-iodine.
↓
Spoon into a beaker and fill with 200 ml of water
↓
When the beaker is same as room temperature, cover it and use a mechanical stirrer to stir.
↓
consider it may not above than one hour
↓
having dissolve suitabley or completely its possible
↓
Titrate it immediately with the help of 0.1M sodium thiosulphate while using 3ml of starch solution.
↓
Added towards the end of the titration as indicator.

### Prepare 0.1 M sodium thiosulphate

Dissolve 24.81 g sodium thiosulphate
↓
500ml of fresh water
↓
2 or 3 drop Chloroform
↓
And complete 1000ml using volumetric flask

1ml of sodium thiosulphate = 0.01269g=12.96mg of iodine is present.

When titration is done it was found to be that 21 ml of sodium thiosulphate has been used towards to achieve end point.

**Drug excipent interaction**

Povidone-Iodine was identified by Fourier transform–infra red absorption spectrophotometer/Differential scanning calorimetry by this method we determine the interaction of drug with its excepients with the help of particular range. Compatibility of the drug towards the excipent are necessary

**Solubility determination**

Solubility is considered according to Indian pharmacopoeia procedure.

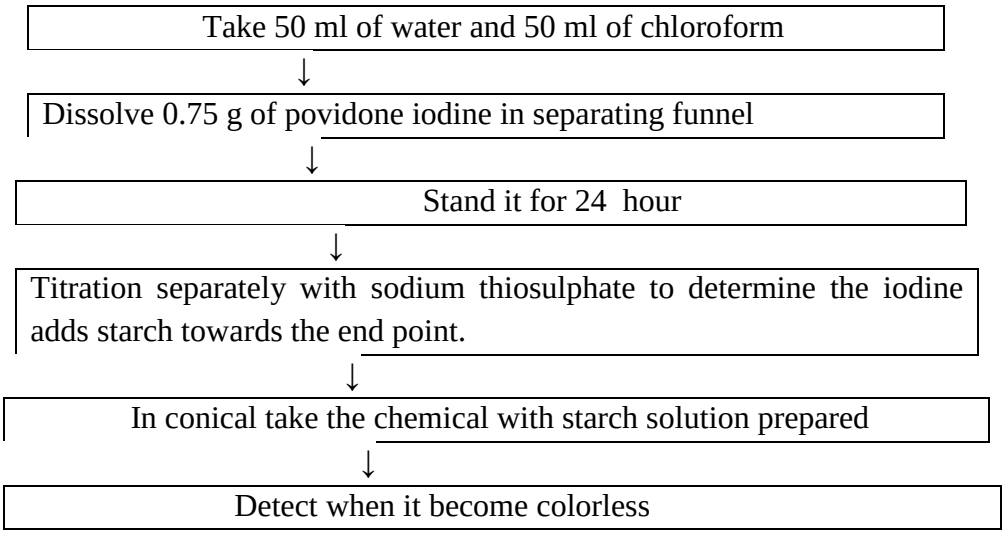
| **Descriptive term** | **Parts of Solvent required for Part of Solute** |
|---|---|
| Very soluble | < 1 |
| Freely soluble | From one to ten |
| Soluble | From ten to Thirty |
| Sparingly soluble | From Thirty to Hundread |
| Slightly soluble | From Hundread to thousand |
| Very slightly soluble | From thousand to Ten Thousand |
| Practically insoluble, or Insoluble | Ten Thousand or more |

**Table for solubility study**

**4.2.7 Partition coefficient determination**

The proportion of solvent levels in two immiscible or mildly miscible liquids, or in two solids, when the interface between them is in equilibrium. To calculate partition coefficient of Povidone-Iodine we use two immiscible solvent like water and chloroform.

**PROCEDURE**



**Determination of wavelength**

A standard stock solution was make by dissolving 10 mg of drug in about 10 ml of adding water and make up the volume up to 100ml of volumetric flask. Making the solution in the range 1-6µg/ml. An UV Spectroscopic scanning (300-600nm) was carried out with the solution to determine the wavelength of maximum absorption.

**Quantitative Estimation of Drug**

100 mg drug was weighed and dissolved in 100 ml of water to give a solution of 1000µg/ml concentration. From this solution 10ml was taken and diluted to 100ml using water to get a stock solution of 100ug/ml .From this stock solution different aliquots ranging 1-10ug/ml were prepared. The absorbance of these solutions was measured at 356 nm by UV spectrophotometer against reference blank distilled water. The data were processed on computer and statistical parameter was determined.

**Preparation of calibration curve**

A series of solution was prepared from the stock solution using water Absorption of each concentration was recorded by UV-Visible spectrophotometer at maximum absorption which are found to be 356nm. A calibration curve was constructed between concentration and mean absorbtion.

**Formulation Development**

**Screening of the component for the preparation of SLNs**

For the preparation of the solid lipid nanoparticle selection of the proper lipid and surfactant are necessary.

**Screening of lipid**

Solubility of drug in melted lipid was one of the best factors that determine the loading capacity of the drug in the lipid. The lipid like GMS, palmitic acid stearic acid was screened for their potential to solubilise the povidone iodine. The fixed amount of drug was taken and added into the melted lipid and stirrer continuously with maintain the temp and the lipid was selected which have high capacity to solublise the povidone drug and it was found to be GMS in comparison to other lipid content.

**Screening of solvent**

For the screening of solvent a known amount of lipid was gradually added in a solvent continuous shaking for several interval of time when it seems to be dissolved completely it will be selected for formulation development.

**Selection of surfactant-**In the research work several surfactants like Polysorbate80,soyalecithin ,Pluronic F68 have been used with different ratio.

**Pre-optimization of several experimental design parameters**

Solubility, surfactant, and lipid were chosen during an initial screening analysis. The pre-optimization of the drug - lipid ratio, surfactant content, and stirring speed came next. The impact of these characteristics was measured using entrapment efficiency and particle size.

**Drug to lipid ratio pre-optimization**

Following an initial lipid screening investigation, GMS was chosen as the lipid phase. Particle size and entrapment efficiency were taken into consideration while optimizing the medication to lipid ratio following lipid selection. Drug (100 mg) was consistently added to lipid solution at several drug-lipid ratios, from 1:2 to 1:9. The remaining variables,

The surfactant content- 1% w/v

The stirrer speed 2000 rpm..

**Pre- optimization of surfactant concentration**

Polysorbate 80 was chosen as a surfactant based on an initial surfactant screening investigation. To prepare SLN, several quantities of Polysorbate80, range 0.5 to 2.5 percent, were used. When the surfactant was applied during the emulsification process, its concentration was adjusted to maximize the particle size, entrapment efficiency, and aggregation after a 24-hour period. Other variables were maintained constant, such as the medication to l ratio of lipid (1:3) and the speed of stirrer (2000 rpm).

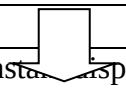
**Pre- optimization of stirring speed**

The production of SLNs occurs when the organic solvents diffuse out in the aqueous phase during stirring. Therefore, stirring time and speed may have an impact on drug entrapment and particle size. The impact of stirring speed was noted and optimized in the current investigation. While other parameters, such as the drug:lipid ratio of 1:3 and the surfactant concentration of 1.5%, were maintained constant, the effect was detected from 1000 to 4000. Pre-optimization studies were used to determine the amounts of three distinct independent variables..

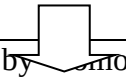
**PREPARATION OF SOLID LIPID NANOPARTICLE**

**Solvent emulsification diffusion method**

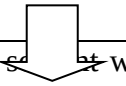
The internal oil phase was mixed in a 1:1 composition of ethanol and chloroform to preserve the solid lipid ratio of 1:2–1:6.



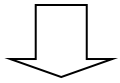
100 mg of the drug constant disperse in the solution



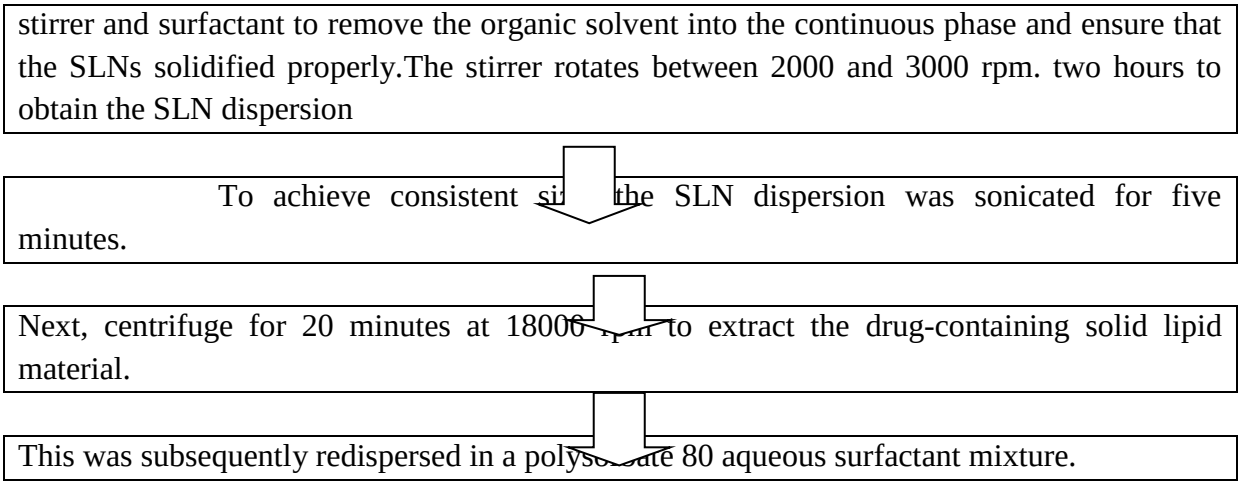
The primary emulsion was formed by homogenizing the organic phase added into homogrnizer tube by drop by drop that have an aqueous solution of P80 (polysorbate80) consider as the external aqueous phase. The homogenization process took 30 minutes at 3000 rpm.



Following homogenization, the organic solvent was eliminated through evaporation using a rotating vacuum evaporator..



The aforementioned emulsion was added to 75 milliliters of ice cold water (2–3 ºC) with a




**Experimental design for optimization**

**To determine the particle size, polydispersity index (PDI) and zeta potential of the Formulation**

To obtain the best counts, all samples were diluted 1:10 with deionized water. By using photon correlation spectroscopy (PCS; Zetasizer, HAS 3000; Malvern Instruments, Malvern, UK), average particle size, zeta potential and PDI were find. At 25ºC, measurements were taken at a 90-degree angle.

**SEM study (Scanning Electron Microscopy)**

By means of scanning electron microscopy (SEM), the optimized SLNs' morphology was investigated.After delicately dusting SLNs dispersion over the double-adhesive carbon tape that was attached to an aluminum stub, the sample was ready for SEM examination.Then, in a high vacuum evaporator running in an argon environment, the stub was covered with gold (200–500Å thickness)along with the assistance of the gold sputter module. After coating, the sample was examined at 25±2 0C with an accelerating voltage of 10 kV and a 24000x magnification using a scanning electron microscope (FEI, USA).

**Determination of percent entrapment efficiency and drug loading**

A specific volume of Povidone-Iodine-SLN dispersion (10 ml) was centrifuged at 18,000 rpm and 20 °C (Singh et al., 2012) (Remi Instruments, Pvt. Ltd, India). A spectrophotometric analysis of the supernatant at λmax of 356 nm was conducted in order to determine the amount of unencapsulated medication. The proportion of drug loading and the percentage of trap effectiveness are calculated.

Drug loading (%) = (Wt – Ws) *100\ (Wt - Ws + Wl)

Drug entrapment efficacy (%) = (Wt -Ws)* 100 \ Wt

where Wt represents the total weight of the drug taken, the product's weight in the supernatant, and the weight of the lipid used to make the SLN.

**Formulation of PVI-SLN gel**

A modest amount of distilled water was used to dissolve carbopol 940 (1% w/w) to create an aqueous dispersion that can hydrate for four to five hours. The aqueous dispersion was supplemented with 10% w/w of propylene glycol, 30 percent w/w of glycerin, and 5 percent w/w of PVI-SLN. The pH was then adjusted by the neutralizing with 0.3 percent

triethanolamine. The gel's ultimate weight was changed to 100 g. the pH and viscosity parameter was measured in order to assess the gel.

**In- vitro release of PI from PVI-SLN**

After prolonged ether anesthesia was used to sacrifice male wistar rats, each rat's abdomen skin was removed. The animal's skin was cleansed with physiological saline after the hair removed with a hair remover .To eliminate any remaining adherent fat, subcutaneous tissue was removed, and the dermis side was cleaned with isopropyl alcohol. After being cleansed with distilled water and wrapped in aluminum foil, the skin was kept in a deep freezer. Rats' full-thickness abdominal skin was used for every penetration experiment. Each skin had a comparable thickness. The skin was secured between the receptor chamber and vertical Franz diffusion cell donor.

The physiological salt combination was put into the receptor chamber. The diffusion cells were kept at 37ºC with a recirculating water bath, and the fluid in the receptor chamber was constantly agitated at 500 rpm.Each formulation contained 1g, or 10 mg of medication, which was carefully inserted into the donor cell. Periodically, the physiological saline within the receptor compartment was withdrawn.

.**Study of the prepared gel(Animal study)**

To determine the importance of the manufactured PVI SLN gel, an animal investigation of the gel is required. The animals used in the study were split up into three groups, each of which had six rats.to inflict a wound The dorsal thoracic region was employed to construct the wound in the aseptic condition of the excision wound model. The initial measurement of the approximately 2cm-long wound area is necessary. The wound was treated with the created formulation and the standard formulation, and the area of the wound was traced in order to document the wound's observation after a few days.The closure percentage is computed.

## RESULT AND DISCUSSION

**Identification and characterization of Povidone-Iodine**

**Physical appearance**

It is brownish red in color powder

**Melting point**

Melting point found to be

| Melting point | ºC | Average ºC |
|---|---|---|
| 1. | 294 | 294 |
| 2. | 297 | |
| 3. | 290 | |

**Table for melting point of drug**

**Assay of Povidone-Iodine**

Assay of Povidone-Iodine was done with the help of sodiumthiosulphate.

1ml of sodium thiosulphate = 0.01269g=12.96mg of iodine is present.

The percentage of iodine is necessary in the Povidone-Iodine.

When titration is done it was found to be that 21 ml of sodium thiosulphate has been used towards to achieve end point.

Calculation-

1ml of sodium thiosulphate= 12.96mg of iodine.

21ml of sodium thiosulphate= 21*12.96=272.16 mg of iodine.

Percentage of iodine in Povidone-Iodine= 272.16/3000mg*100=9.072%

So, it was found to be 9.072%.

**Partition coefficient-**

1ml sodium thiosulphate used=12.96mg iodine

Ko/Kw= conc. in oil/conc. in water

Used sodiumthiosulphate= 0.7ml

Calculation of iodine = 0.6*12.96

=7.8%

According to assay iodine in Povidone-Iodine sample it was found to be 9.07%

Chloroform=0.84mg

Ko/Kw=0.84/7.8 = 0.1076

Log (0.1076) = -0.9681877

It means the drug is highly hydrophilic.

**Drug excipient interaction**

Drug excipient interaction study was done by IR spectrophotometer .FTIR spectra of PVI,GMS and PVI+GMS was taken on the basis of peak of spectra of PVI+GMS . It was that there is no any interaction found between PVI and GMS can be selected for further study.

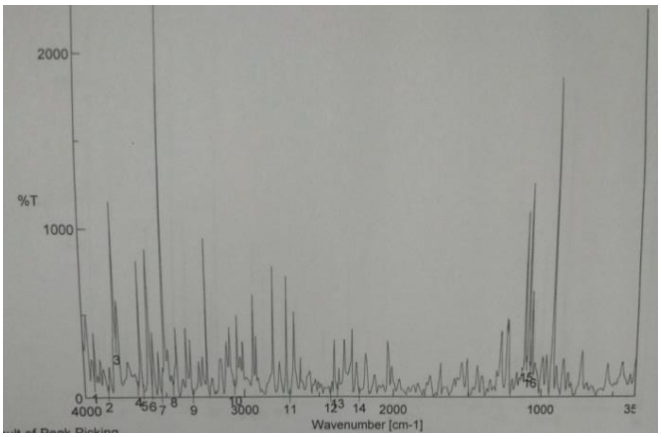



**Fig- FTIR Spectra of PI**

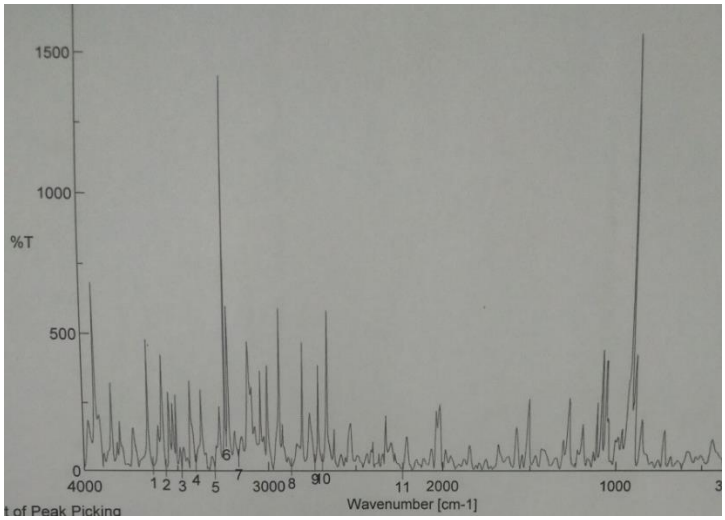



**Fig- FTIR Spectra of GMS**

**Solubility study**

Solubility was consider according to Indian pharmacopoeia procedure. The solubility of Povidone-Iodine are found to be

| **Solvent** | **Solubility** |
|---|---|
| Water | Freely soluble |
| Alcohol | Soluble |
| Chloroform, Acetone | Insoluble |
| Ethanol | Very Soluble |

**Table for solubility study**

**Ultraviolet Absorbtion maxima**

A standard solution (4µg/ml) of Povidone-Iodine was prepared in water and scanned spectrophotometrically between 300- 800 nm. The wavelength maxima found to be 356nm.

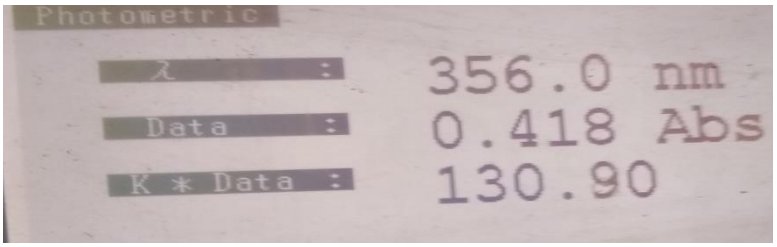



**Fig For the λmax**

λmax=356nm.

**Quantitative Estimation of Drug**

| **Absorbance** | **Conc.(µg/ml)** |
|---|---|
| 0.121 | 1 |
| 0.219 | 2 |
| 0.385 | 3 |
| 0.517 | 4 |
| 0.689 | 5 |

**Table For absorbance**

Y= 0.136x+0.008

**Preparation of calibration curve**

The calibration curve are drawn between the absorbance obtain by the UV spectroscopy and the concentration**.**

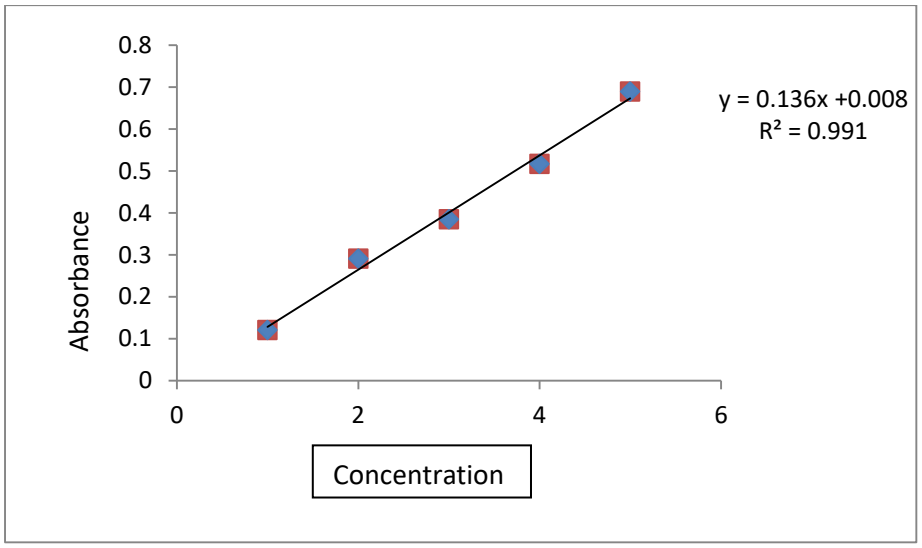



**Fig Graph between the absorbance and concentration**

**Lipid Screnning**

| **s.no.** | **melting point** | **lipid** | **soluble drug** | **lipid amount** |
|---|---|---|---|---|
| 1. | 58-59 | GMS | 70mg | 100mg |
| 2. | 62.9 | Palmatic acid | 45mg | 100mg |
| 3. | 69.8 | Stearic acid | 15mg | 100mg |

**Table for lipid Selection**

In the study mentioned above, we discovered that the GMS have higher drug solubility compared to another lipid, which was reported to be 70%. Lipid screening is required to ascertain the solubility of the medication to the lipid. GMS was therefore chosen to formulate the SLN.

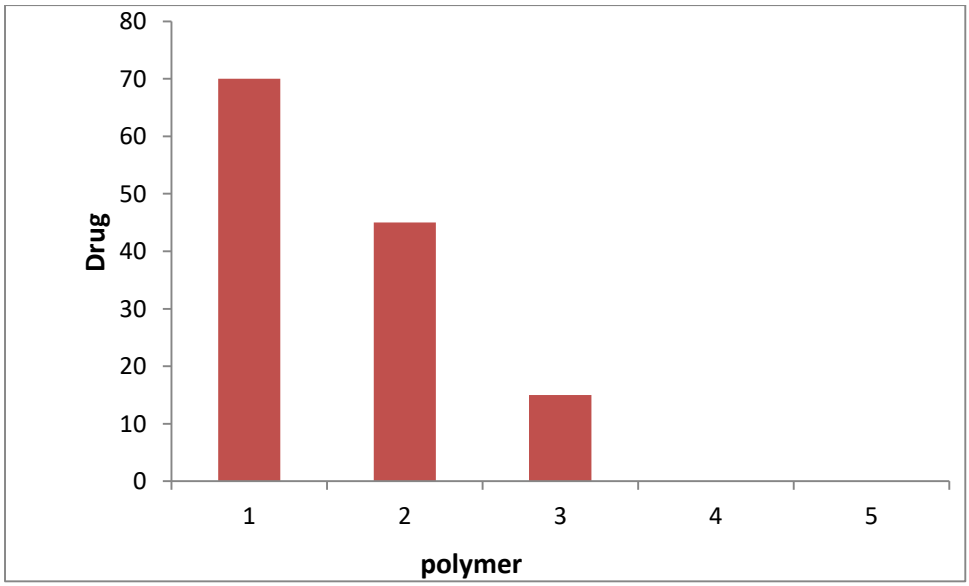



**Fig Shows the maximum solubility of drug**

**SELECTION OF SURFACTANT**

| lipid (mg) | Drug(mg) | Entrapment efficacy (%) | Surfactant | particle size |
|---|---|---|---|---|
| 300mg | 100mg | 88.83 | 2 | 285.4nm |
| 300mg | 300mg | 86.32 | 1.5 | 335nm |
| 300mg | 300mg | 84.36 | 2.5 | 435nm |

**Table For the selection of the surfactant**

Through surface-mediated crystal formation, the surfactant coating at the interface may affect the stability and crystal structure of solid lipid nanoparticles. The outcome demonstrates that at 2% surfactant content, the best entrapment performance and particle size were achieved.

**Entrapment efficacy**

10 milliliters of the SLN dispersion were obtained, and it was centrifuged for 15 minutes at 18,000 rpm.The lipid fraction was separated, and the drug's absorbance in the supernatant was measured using spectrophotometry at 356 nm.The equation was used to calculate the entrapment efficacy percentage.

DRUG LOADING (%) = (WT – WS) *100\ (WT - WS + WL)

DRUG ENTRAPMENT EFFICACY (%) = (WT -WS)* 100 \ WT

where WL is the weight of the lipid used to make the SLNs, Wt is the total weight of the drug utilized, and Ws is the weight of the drug in the supernatant.

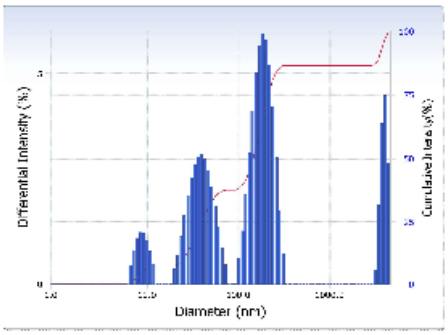
| S.NO. | RATIO OF DRUG LIPID | FORMULATION | %DRUG LOADING | ENTRAPMENT EFFICACY (%) |
|---|---|---|---|---|
| 1. | 1:2 | . GSLN1. | 32.65 | 87.83% |
| 2. | 1:3 | . GSLN2 | 33.50 | 88.83% |
| 3. | 1:4 | . GSLN3 | 19.40 | 86.59% |
| 4. | 1:5 | . GSLN4 | 16.30 | 82.53% |
| 5. | 1:6 | . GSLN5 | 13 | 77.53% |
| 6. | 1:7 | . GSLN6 | 32.56 | 77.42% |
| 7. | 1:8 | . GSLN7 | 24.73 | 78.56% |
| 8. | 1:9 | . GSLN8 | 19.55 | 76.52% |
| 9. | 1:10 | . GSLN9 | 16.18 | 75.32% |

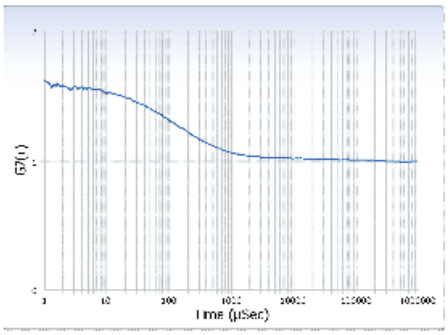
**Table Optimization of formulation**

In this we found that the 1:3 formulations having good Entrapment efficacy in comparison to other so we selected the 1:3 ratio for further formulation. In the optimized formulation of SLN the Drug:- Lipid ratio 1:3 was used .The suitable surfactant polysorbate was use 2%.

**Determination of particle size, poly disparity index**

The particle size and poly disparity determination are necessary for the optimization of the SLNs formulation it determine the accuracy of the SLNs production in formulation.




Distribution Results (Contin)

| Peak | Diameter (nm) | Std. Dev. |
|---|---|---|
| 1 | 9.7 | 1.6 |
| 2 | 43.2 | 12.8 |
| 3 | 199.8 | 50.0 |
| 4 | 4,088.9 | 362.5 |
| 5 | 0.0 | 0.0 |
| Average | 662.9 | 1,362.0 |
| Residual : | 4.731e-002 | (N.G) |

Cumulants Results

| | | | |
|---|---|---|---|
| Diameter | (d) | : 285.4 | (nm) |
| Polydispersity Index | (P.I.) | : 0.199 | |
| Diffusion Const. | (D) | : 1.724e-008 | (cm²/sec) |
| Molecular Weight | | : 3.366e+009 | |
| Measurement Condition | | | |
| Temperature | | : 25.0 | (°C) |
| Diluent Name | | : WATER | |
| Refractive Index | | : 1.3328 | |
| Viscosity | | : 0.8878 | (cP) |
| Scattering Intensity | | : 27556 | (cps) |
| Attenuator 1 | | : 12.61 | (%) |

**Fig Determination of particle size**

The particle size was found to be very nano in range about 285nm The lower range particle size of solid lipid nanoparticle formulation have better result in topical application due to greater penetration**.**

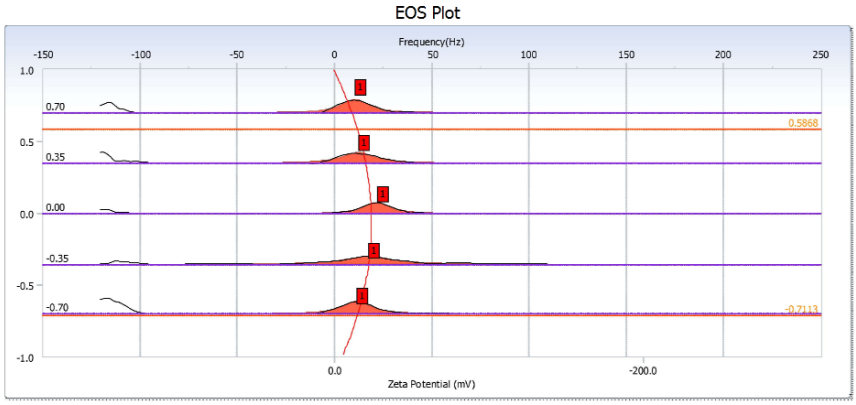
Particle size=285.4nm

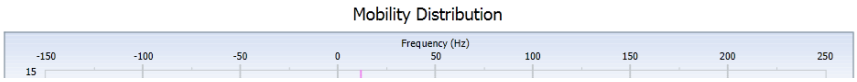
PDI=0.199

Formulation= 1:3

## Zeta potential

Zeta potential is a logical term for electrokinetic potential in colloidal scatterings. In the colloidal science writing, it is typically signified utilizing the Greek letter zeta



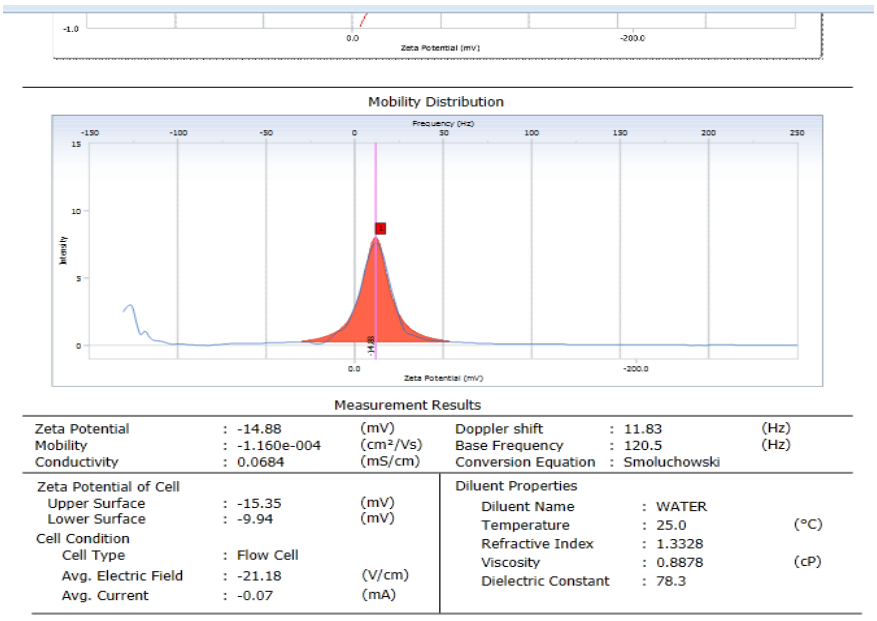



**Fig Zeta potential of optimize formulation**

Zeta potential value shows the stability of the formulation it should be in suitable range. The range was found to be -14.88mV which is acceptable.

**Scanning electron microscopy**

Utilizing scanning electron microscopy (SEM), the morphology of the optimized SLNs was examined. To prepare the sample for SEM inspection, a double-sided carbon tape was attached to an aluminum stub, and SLNs dispersion was softly sprinkled on it. And it was discovered that the structure was spherical..

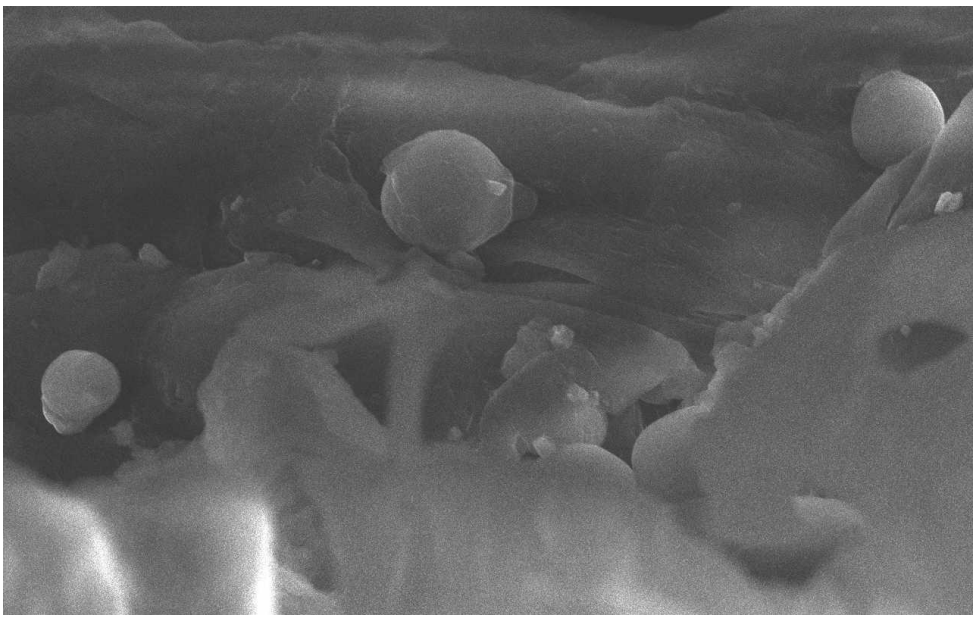


**Fig SEM of the optimize sample**

**Viscosity and the pH of the Gel**

To determine the viscosity of the Gel Brookfield viscometer was used to determine the viscosity by using Spindle no. 07 at $32^{0.}$ pH of gel was determine by digital pH meter. The results are as follows

Viscosity are found to be = 42140 ±0.3 cps at 32ºC

pH was found to be = 5.8

**- Percentage Cumulative Drug Release of all formulation**

| **Time Hrs** | **Percentage cumulative of drug release** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **GSLN 1** | **GSLN 2** | **GSLN 3** | **GSLN 4** | **GSLN 5** | **GSLN 6** | **GSLN 7** | **GSLN 8** | **GSLN 9** |
| **0** | 0±0 | 0±0 | 0±0 | 0±0 | 0±0 | 0±0 | 0±0 | 0±0 | 0±0 |
| **0.5** | 16± 0.07 | 13± 0.09 | 14± 0.13 | 12± 0.09 | 11± 0.10 | 13± 0.11 | 12± 0.14 | 16± 0.50 | 18± 0.24 |
| **1** | 18± 0.30 | 21± 0.22 | 18± 0.14 | 21± 0.19 | 18± 0.36 | 17± 0.12 | 19± 0.10 | 19± 0.32 | 23± 0.15 |
| **2** | 23± 0.13 | 25± 0.32 | 23± 0.05 | 25± 0.14 | 21± 0.43 | 22± 0.11 | 21± 0.38 | 21± 0.23 | 25± 0.21 |
| **3** | 31± 0.22 | 35± 0.09 | 34± 0.32 | 30± 0.21 | 30± 0.34 | 29± 0.31 | 25± 0.8 | 27± 0.34 | 35± 0.19 |
| **4** | 40± 0.26 | 50± 0.18 | 45± 0.06 | 42± 0.36 | 35± 0.24 | 35± 0.21 | 30± 0.14 | 34± 0.26 | 40± 0.38 |
| **5** | 45± 0.16 | 55± 0.12 | 51± 0.38 | 45± 0.39 | 40± 0.39 | 44± 0.13 | 35± 0.19 | 40± 0.39 | 45± 0.32 |
| **6** | 53± 0.21 | 63± 0.54 | 62± 0.20 | 50± 0.17 | 45± 0.19 | 46± 0.18 | 40± 0.06 | 45± 0.21 | 52± 0.16 |
| **7** | 60± 0.18 | 68± 0.29 | 67± 0.31 | 58± 0.07 | 57± 0.18 | 54± 0.33 | 51± 0.19 | 55± 0.9 | 60± 0.38 |
| **8** | 64± 0.40 | 73± 0.18 | 72± 0.09 | 65± 0.32 | 63± 0.24 | 63± 0.27 | 58± 0.24 | 60± 0.11 | 68± 0.32 |
| **10** | 69± 0.17 | 76± 0.19 | 74± 0.29 | 69± 0.23 | 68± 0.31 | 68± 0.42 | 68± 0.29 | 67± 0.22 | 71± 0.19 |
| **12** | 72± 0.19 | 81± 0.30 | 76± 0.32 | 76± 0.25 | 72± 0.21 | 74± 0.27 | 73± 0.30 | 74± 0.29 | 78± 0.10 |

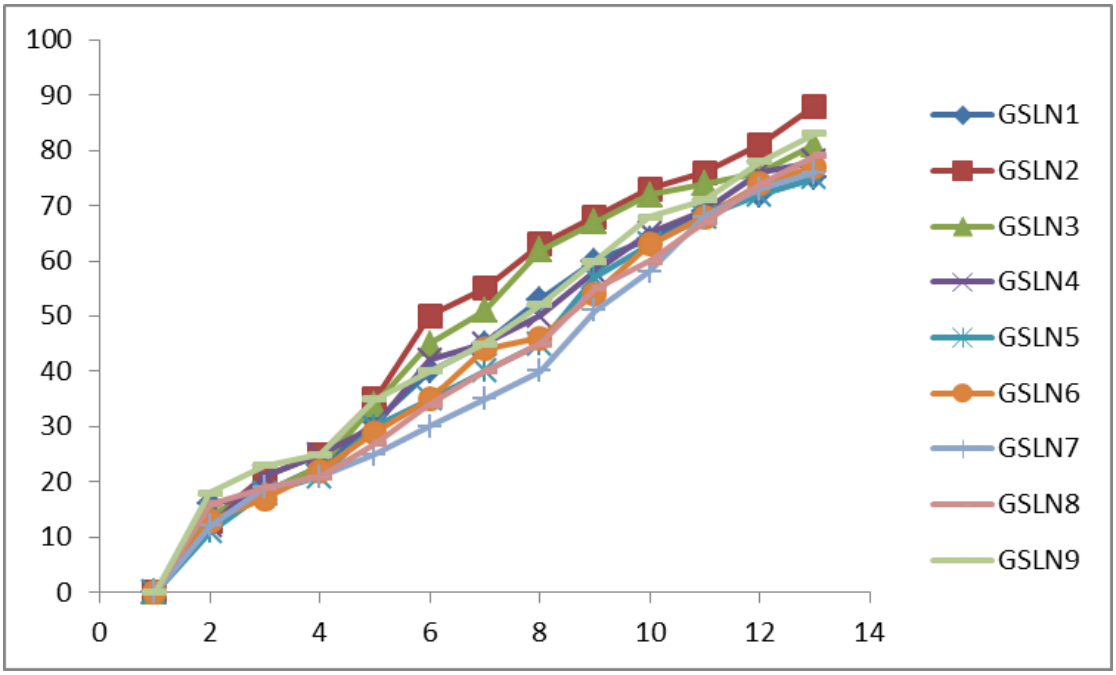



**Fig Graph between the % cumulative drug release and time**

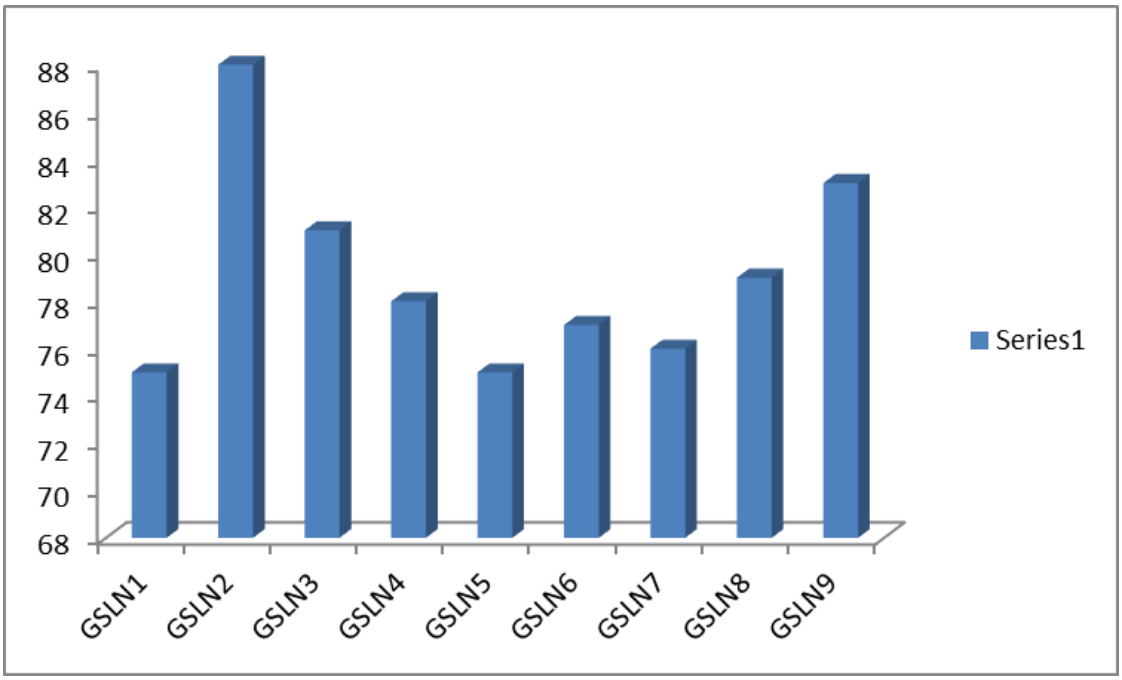


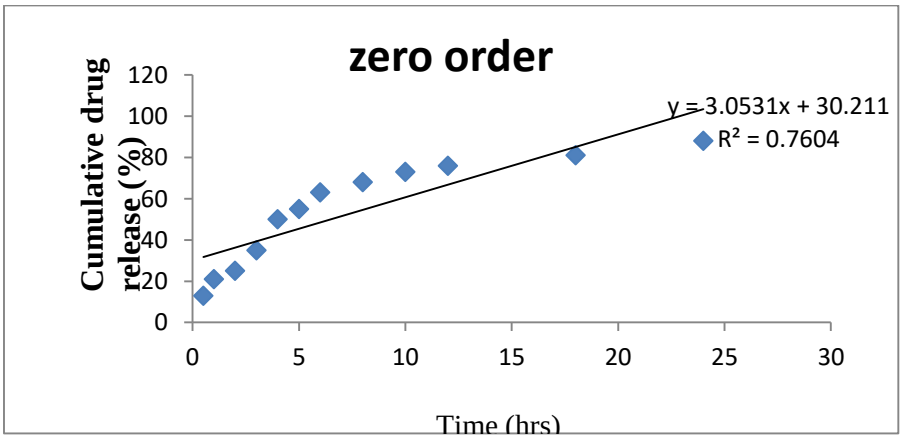

**Fig Graph between %cumulative drug release and Formulation**

The graph displays the medication release percentage for each formulation. It was discovered that the GSLN2 (gel integrated SLN) formulation performed better than the other formulations, with a drug release percentage of almost 88%.

**Release Data**

| TIME (HRS.) | TIME SQUARE ROOT OF | LOG T | CUMULATIVE DRUG RELEASE % | LOG CUMULATIVE DRUG RELEASE % | CUMULATIVE DRUG REMAINING% | LOG CUMULATIVE DRUG REMAINING | CUBE ROOT OF CUMULATIVE DRUG RELEASE % |
|---|---|---|---|---|---|---|---|
| 0.5 | 0.71 | -0.30 | 13 | 1.113 | 98.887 | 1.9951 | 1.25889 |
| 1 | 1 | 00 | 21 | 1.322 | 98.678 | 1.9942 | 1.25870 |
| 2 | 1.41 | 0.301 | 25 | 1.397 | 98.603 | 1.9938 | 1.25861 |
| 3 | 1.73 | 0.477 | 35 | 1.544 | 98.456 | 1.9932 | 1.25849 |
| 4 | 2 | 0.602 | 50 | 1.698 | 98.302 | 1.9925 | 1.25834 |
| 5 | 2.23 | 0.698 | 55 | 1.740 | 98.26 | 1.9923 | 1.25830 |
| 6 | 2.45 | 0.778 | 63 | 1.799 | 98.201 | 1.9921 | 1.25825 |
| 8 | 2.82 | 0.903 | 68 | 1.832 | 98.168 | 1.9919 | 1.25821 |
| 10 | 3.162 | 1 | 73 | 1.863 | 98.137 | 1.9918 | 1.25819 |
| 12 | 3.464 | 1.079 | 76 | 1.880 | 98.12 | 1.9917 | 1.25817 |
| 18 | 4.242 | 1.255 | 81 | 1.908 | 98.092 | 1.9916 | 1.25815 |
| 24 | 4.898 | 1.38 | 88 | 1.944 | 98.056 | 1.9914 | 1.25812 |

**Table Drug release of kinetic of optimize formulation-**




**Zero order kinetics**

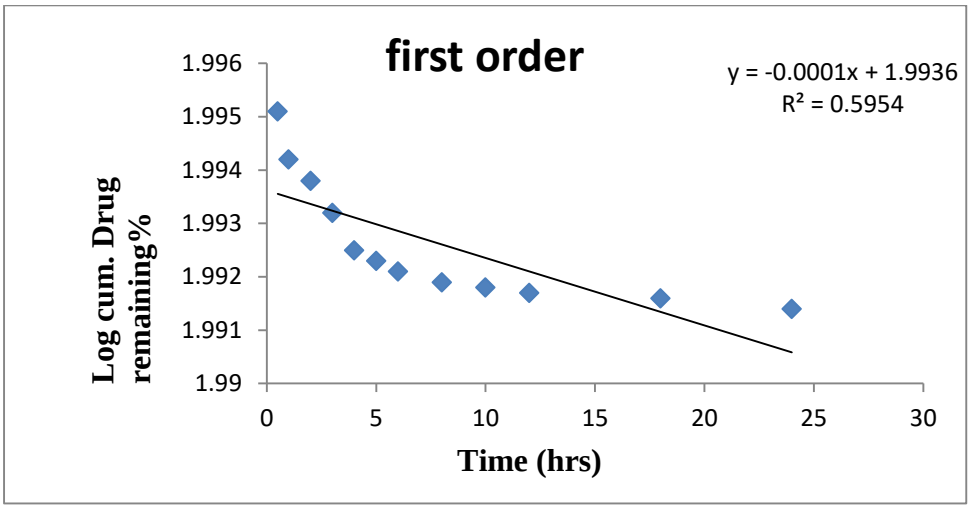



**Fig first order Kinetics**

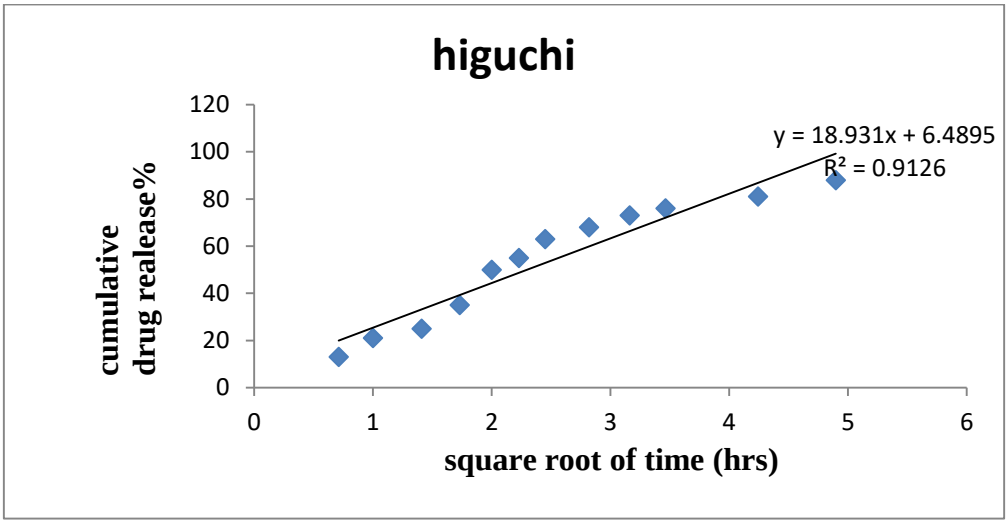



**Fig Higuchi model**

According to huguchi model the data are fit for the formulation drug release.

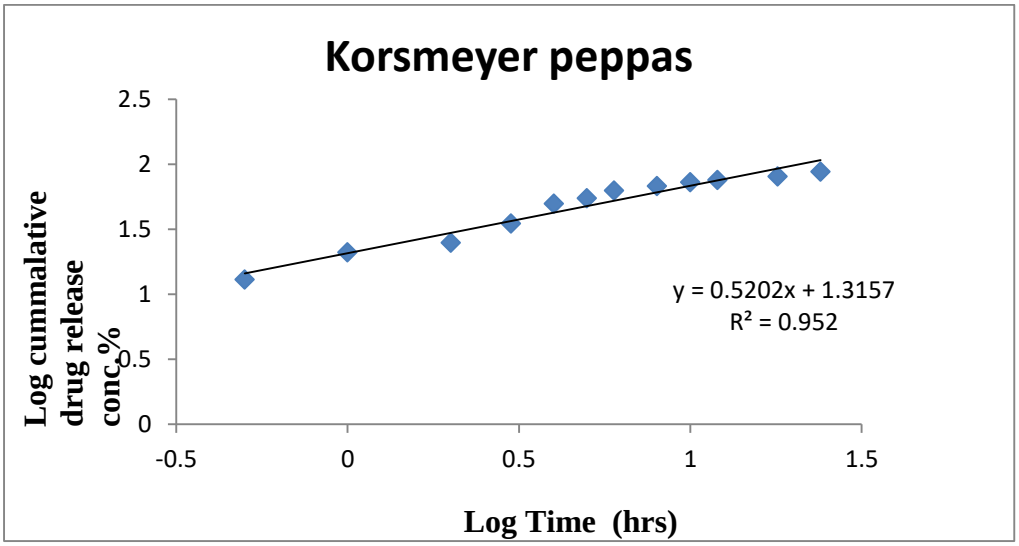



**Fig korosmemeyer peppas graph**

According to graph Release Kinetics of the korsmeyer peppas is fit for the formulation drug release.

**Animal activity-**

**Experimental animal studies**

In animal study we measure the wound contraction size along with time. There are 3 groups on the basis on animal study and each group having 6 rat. According to the model that is Excision model about 2cm of wound have been created and healing of the wound should be measured by day. 500 mg gel was applied on the wound for study in the second group marketed formulation which contain 25 mg of Povidone-Iodine was applied same the 500 mg SLN incorporated gel was applied in 3rd group these contain 8.5 mg drug. these result sows that there was no significance difference was found in second and third group means wound healing produce by SLN loaded gel is nearly equivalent to wound healing produced by marketed preparation but the amount of drug in both formulation is different on the basis of result it can be concluded that SLN loaded gel is more potent tan marketed preparation.

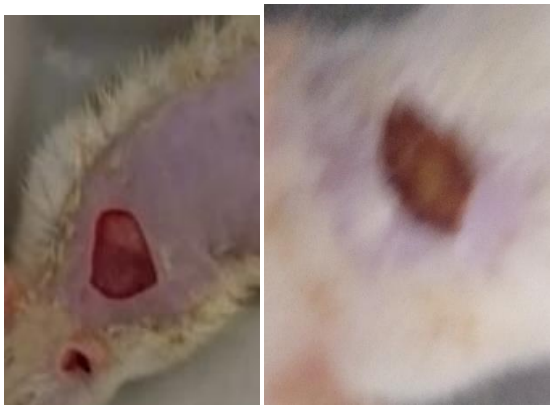


**Fig Normal group treated with blank gel**

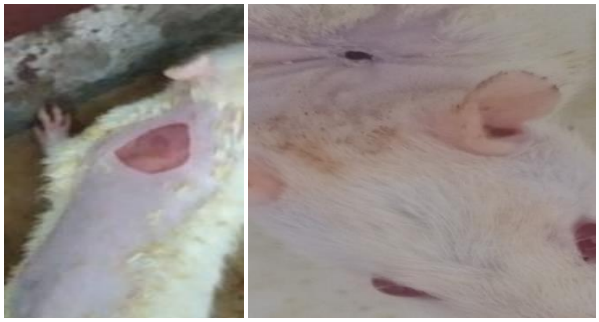


**Fig Tested groups treated the GSLN containing PVI-SLN gel**

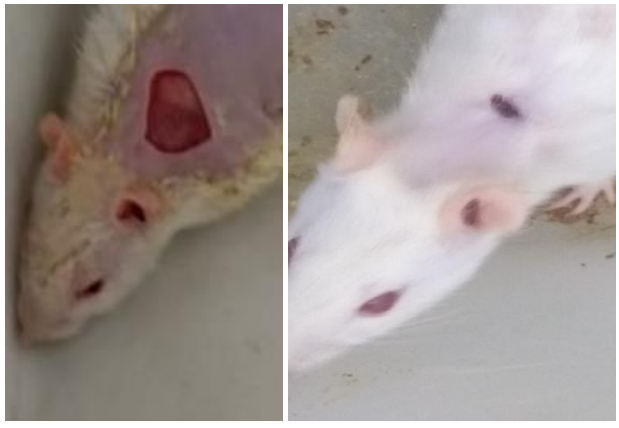


**Fig 5.18 Standard group treated with standard formulation**

| Groups (n=6) | Healing of wound(cm) on 15 th day |
|---|---|
| **Control Group** | 2.633333333 ± 0.048419463 |
| **Standard Group** | 1.636666667 ± 0.047935141 **a** |
| **Test Group** | 1.626666667 ± 0.04772607 **a** |

All

**Table wound contraction in cm**

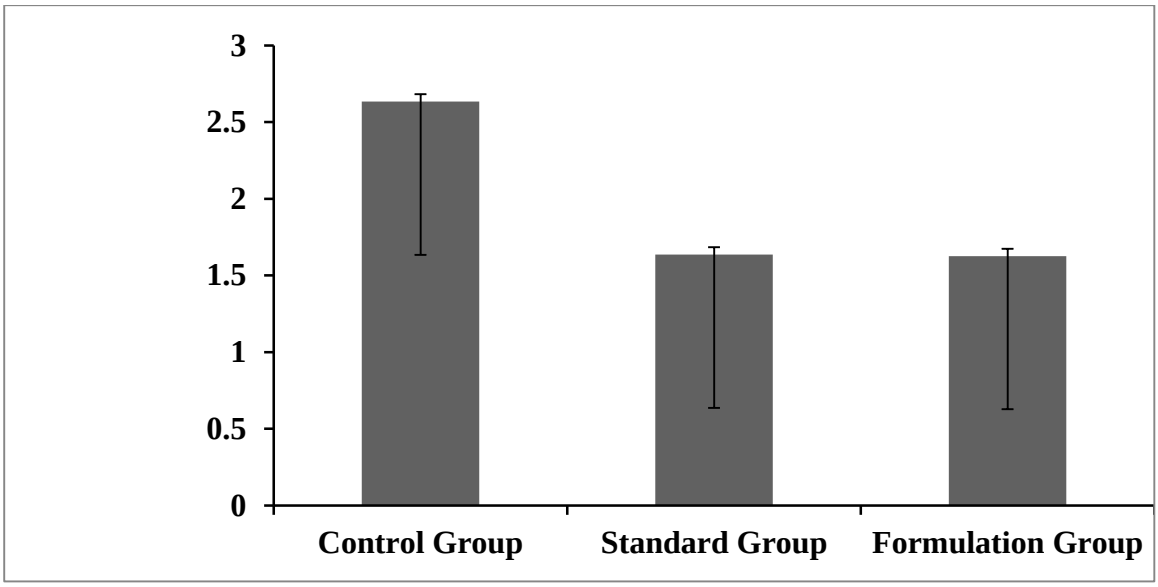



**Fig Animal Group data graph**

In this graph its shown that the wound contraction or wound area are decreased after the treatment it was vary group to group control group have very less decrease in wound area and standard and Formulation having better result.

## Conclusion:

To fulfill the objectives of present research project, Povidone-Iodine antiseptic drug were selected and procured. On the basis physicochemical characterization and identification studies, it could be concluded that the procured drug samples were pure and authentic. For the optimization, 3 levels of each independent variable (i.e. drug to lipid ratio, surfactant concentration and Entrapment efficacy) were decided on the basis of results of preliminary screening studies and their effects were observed on dependent variables particle size, entrapment efficiency & drug loading). Optimized formulations were evaluated for particle size, PDI, zeta potential, entrapment efficiency, *in vitro* release and stability studies.

The melting point of the Povidone-Iodine is found to be 294ºCand the assay of the sample drug was done to measure the amount of Iodine present in the Pvidone Iodine sample which was found to be 9.072 %. On the basis of partion coefficient it could be say that the drug is highly hydrophilic. Results of FTIR shows that there was no interaction found between PVI and GMS. On the basis of pre optimization study lipid GMS and surfactant polysorbate 80 were selected for formulation of SLN. Solvent emulsification diffusion method was used for preparation of SLN. The optimized formulation GSLN2 was selected on the basis of their particle size and entrapment efficiency which were found to be 285.4 nm and 88% respectively. The value of Zeta Potential

-14.88Mv was obtained for GSLN2. Result of SEM shows that the spherical shapes SLN were formed. Topical formulation gel was prepared by using 1% Carbapol and 5% GLSN2 the viscosity and pH are obtain 42140 ±0.3 and 5.8 The excision model was for animal study. On the basis of animal study it can be concluded that

Final it can be concluded that prepared PVI-GSLN have good healing capacity due to its less particle size and good controlled release of drug.

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