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Research

Formulation and Evaluation of Herbal Drugs Based Solid Lipid Nanoparticles for Sustained Release

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Abstract

Emergence of micro- and nanotechnology, along with advances in proteomics, for example genomics, and combinatorial chemistry, have given researchers and engineers new tools to develop innovative, high-tech drug delivery systems. Herbal solid lipid nanoparticles' lipid composition allows them to rationally improve upon existing formulations' shortcomings in areas like as solubility and bioavailability. Formulating and evaluating herbal solid lipid nanoparticles for prolonged medication release is the goal of the present study.. Extracts were prepared and antioxidant and free radical scavenging activities of several Tridax daisy L. extracts were evaluated using DPPH and Nitric Oxide, two popular free radical scavenging protocols. Using a heat homogeneity followed by ultrasound treatment technique and three different amounts of solid lipid, this work synthesised Tridax daisy. L. loaded SLNs. The zeta potential, particle size distribution, and PDI values of all the produced formulations were calculated. All of the formulations had an average size that varied between 167.49±2.13 nm and 285.61±2.64 nm. The small size distribution was shown by the PDI, which ranged from 0.216±0.01 to 0.426±0.02. The results showed that the SLNs formulations had an entrapment efficiency ranging from 59.86±1.42 to 72.51±1.34%. The surface morphology of the SLNs formulation shows that when the particle size rose due to the lyophilization procedure, the agglomeration phenomena became more pronounced, despite the particles' smooth surfaces and spherical shapes. The drug released from the suspension in PBS pH 6.8 (1% SLS) was nearly 100% in 6 hours. After oral administration, the enterocytes might absorb the SLNs, which would be favourable for achieving the intended therapeutic effect, due to the minimal drug release of Tridax daisy L. from the SLNs. The formulation's lipid content shows promise for the creation of medicinal formulations that can be delivered orally.

Keywords: Tridax daisy, Herbal Drugs, Solid Lipid Nanoparticles, Sustained Release.

INTRODUCTION

In the twenty-first century, nanotechnology is showing great promise as a tool. Using nanoscience in pharmaceuticals is known as pharmaceutical nanotechnology. It is already commonplace in the pharmaceutical industry to talk about new medication delivery methods that make use of nanomedicine design. \Liposomes, dendrimers, polymeric micelles, nanospheres, niosomes, and, more latter, carbon nanotubes and quantum dots, among other nanomedicine, have allowed for increasingly precise molecular-level illness diagnosis and therapy thanks to pharmaceutical nanotechnology. Drug delivery systems based on nanoparticles have had a profound effect on almost every medical specialty, from general internal medicine to fields as diverse as immunology, ophthalmology, oncology, pulmonology, and gene delivery, tumour targeting, oral vaccine formulations, and more. There has been meteoric growth in the pharmaceutical nanotechnology industry over the past 20 years, particularly in the diagnostic and drug carrier markets.[1] Liposomes, nanoparticles, polymer micelles, dendrimers, monoclonal antibodies, and modified nanosystems are among the medicinal nanotechnology products that have been approved and are now available for purchase. Nevertheless, there are still significant obstacles to overcome, such as clinical and regulatory concerns, uncertainties over potential health risks, and a lack of clarity regarding safety concerns.[2]

Emergence of micro- and nanotechnology, along with advances in proteomics, for example genomics, and combinatorial chemistry, have given researchers and engineers new tools to develop innovative, high-tech drug delivery systems. Advanced drug delivery systems are generally considered to have met the following criteria: tissue targeting, controlled absorption kinetics, minimal immune response, ease of administration in order to ensure patient compliance, and the capacity to deliver traditionally difficult drugs, including those that are lipophilic, amphiphilic, or biomolecules. Reducing side effects and making administration easier are modern drug delivery criteria. These include the targeted and controlled transport of medicines, proteins, and genes into cells.[3]

Absorption into plasma from the site of administration, distribution to tissues, metabolism in tissues, and excretion from the body are the four basic pathways of drug transport and modification that determine the therapeutic efficacy of the drug. Substance hydrophobicity, chemical milieu, particle size, crystallinity, blood flow, absorption surface area, and residence duration at an absorption surface are among the several variables that determine absorption rate. When it comes to drug distribution, factors including hydrophobicity, ligand binding, capillary permeability (like the blood-brain barrier), and blood flow are crucial. All of the aforementioned characteristics are crucial for the metabolism and removal of drugs.[4]

Because of its potential influence on each pathway, the means of delivering drugs is an essential part of pharmaceutical science's design process. The pharmaceutical sciences have been working tirelessly over many decades to find a solution to the problem of regulated and targeted administration of medications that are not highly water soluble.

Novel drug delivery system

Among the numerous advantages of novel drug delivery systems are better therapy (due to longer and more effective drug activity), higher patient compliance (due to less frequent dosing and more convenient administration routes), and better targeting to a specific site (due to fewer adverse effects). The delivery of both current and future medication technologies presents a challenge for the pharmaceutical and drug delivery industries, with the goal of maximising patient benefit.[5]

Achieving a potentially effective and nontoxic consistent blood or tissue level over an extended period of time is the main goal of innovative drug delivery systems. The use of nanotechnology in novel medication delivery and formulation technologies is changing the face of medicine. Here are some examples of nanoparticulate drug delivery systems: solid-lipid nanoparticles, lipid nanoparticles, carbon nanotubes, nanocrystals, nanoparticles of metallic material, nanoparticles with magnetic characteristics, albumin nanoparticles, fullerene nanoparticles, and polymeric nanoparticles. Mesoporous silica nanoparticles are another type of nanoparticulate drug delivery system.[6]

Aim and Objectives

Formulating and evaluating herbal solid lipid nanoparticles for prolonged medication release is the goal of the present study. Herbal solid lipid nanoparticles' lipid composition allows them to rationally improve upon existing formulations' shortcomings in areas like as solubility and bioavailability.

- To counteract the side effects of synthetic drugs and improve the efficacy and safety of treatment, use standardised herbal remedies and formulations.
- An inexpensive, repeatable, and safe herbal composition needs to be created and tested if wounds caused by non-steroidal anti-inflammatory medications are to heal faster.
- The selection of robust bioactive fractionates with prospective wound healing capabilities was achieved through preliminary screening for wound healing potential versus steroidal anti-inflammatory drugs.

- ❖ The solubility and entrapment of Tridax daisies in various lipids, surfactants, and stabilisers are being examined in this research.
- ❖ In order to investigate the physical and chemical properties of solid lipid nanoparticles, including their drug content percentage, particle size, polydispersibility index, zeta potential, and in vitro release, among other things.
- ❖ The goal is to optimise a batch, decrease particle size, and increase zeta potential in order to maximise drug release in vitro.
- ❖ Get the Tridax daisy microemulsion gels ready by making them with Carbopol 934 NF as the base. Then, test them for various physicochemical parameters as drug content, pH, zeta potential, particle size, and rheology.
- ❖ Potentially, the compatibility of drugs and excipients can be investigated using FTIR and scanning electron micrographs (SEM).
- ❖ To conduct stability testing on the chosen items in accordance with ICH criteria.

MATERIALS & METHODS

Materials and Equipment

The following are the list of Active Pharmaceutical Ingredients (API), Excipients and Chemicals procured from various sources, utilized to carry out the current research work.

Table 1: List of materials used in research work

S.No.	API/Chemical	Manufactures/suppliers
1	Compritol 888ATO	Gattefosse India Pvt. Ltd (Mumbai, India)
2	Precirol ATO 5	Gattefosse India Pvt. Ltd (Mumbai, India)
3	Stearic Acid	SD Fine-Chem Limited, (Mumbai, India)
4	Palmitic acid	SD Fine-Chem Limited, (Mumbai, India)
5	Glyceryl monostearate	SD Fine-Chem Limited, (Mumbai, India)
6	Poloxamer	Sisco research laboratories Pvt.ltd –Maharashtra
7	Cholesterol	Sisco research laboratories Pvt.ltd –Maharashtra
8	Tween 80	Sisco research laboratories Pvt.ltd –Maharashtra
9	Tween 20	Sisco research laboratories Pvt.ltd –Maharashtra
10	Span 20	Sisco research laboratories Pvt.ltd –Maharashtra
11	Span 80	Sisco research laboratories Pvt.ltd –Maharashtra
12	Potassium dihydrogen Phosphate	SD Fine-Chem Limited, (Mumbai, India)
13	Formic acid	BASF, Mumbai, India
14	Ethanol	Merck, Mumbai, India
15	Chloroform	Merck, Mumbai, India
16	Mannitol	Loba Chemie Pvt Ltd–Maharashtra
17	Sodium lauryl sulphate	Loba Chemie Pvt Ltd–Maharashtra
18	PEG 200	Loba Chemie Pvt Ltd–Maharashtra
19	PEG 400	Loba Chemie Pvt Ltd–Maharashtra
20	Dichloromethane	Merck, Mumbai, India

Table 2: List of equipment's used in research work

S.No	Equipments	Manufactures
1	Electronic balance	Schimadzu, Japan
2	Digital pH meter (LI-10T)	Elico
3	FT-IR spectrophotometer (Alpha)	Bruker, Germany
4	Ultra & cooling centrifuge	REMI
5	Distillation Unit Apparatus	Nirmal International, New Delhi, India
6	UV visible spectrophotometer	Schimadzu, Japan
7	Franz diffusion cell apparatus	Lab India
8	High speed homogenizer	CAT, Germany
9	Ultra sonicator	Q Sonica, Germany
10	Stability chamber	Thermolab, India
11	Particle size analyzer (SZ 100qa)	HORIBA, Japan

12	Scanning electron microscope	Hitachi s-3000N
13	Bath sonicator	Q Sonica, Germany
14	Magnetic stirrer	Remi Instruments Ltd., Mumbai, India
15	Melting point apparatus	HICON apparatus, New Delhi, India
16	Probe Sonicator (US-250W)	Altrasonics, Mumbai, India
17	Centrifuge	Remi Lab, Mumbai, Indi
18	Zeta Sizer	Malvern instrument, Worcestershire, USA
19	Dialysis bag (M.Wt. cut off 12000-14000 Da)	Hi Media, Mumbai, India

Tridax procumbens
Botanical Name: Tridax procumbens (L.)
Common Name: Pardesi Bhangaro, Tridax Daisy, Coat Buttons, Mexican Daisy
Plant Family: Asteraceae (Compositae)
Plant Form: Herb
Occurrence (Special Areas): Indroda Park, Punit Van, Sarita Udyan, Basan, Aranya Van
About Tridax procumbens Plant:
Habit: A small, straggling, procumbent, perennial hairy, herb.
Leaves: Opposite, ovate-elliptic, acute, deeply inciso-dentate, hairy-glandular.
Inflorescence: Capitulum (Head)
Flowers:

- Yellow with tall, hairy peduncles and pale yellow flowers in a cluster. Hairy involucral bracts.
- Feathered hairs on the pappus of ligulate, yellow, ray florets.
- Disk florets bisexual, corolla regular, tubular, pentafid.
- Anthers sagittate.

Fruits: Cypsela oblong densely covered with silky hairs, black.
Flowering and Fruiting Time: All the year round.
Significance: Common weed everywhere.
Taxonomic Free
Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonae
Order: Asterales
Family: Asteraceae
Genus: Tridax
Species: Tridax procumbens
Notes on Taxonomy and Nomenclature
Everyone agrees that this species belongs in its proper taxonomic category. Tridax refers to flowers with three rays, and procumbens describes prostrate and trailing stems.

Uses

T. procumbens has a wide range of potential applications, including wound healing, bleeding control, diarrhoea, backache and bronchial catarrh therapy. Research has demonstrated that plant extracts can slow down Culex quinquefasciatus larvae. Laboratory observations reveal that the juvenile stages of Meloidogyne incognita are killed by leaf extracts of T. terrestris, and root galling by this worm is reduced by T. terrestris leaf powder. Some studies have shown that essential oils extracted from T. procumbens can kill some types of insects, including Musca domestica, Culex quinquefasciatus, Dysdercus similis, and Supella specie. A floral petroleum ether extract protects cowpea seeds from the bruchid Callosobruchus maculatus, whereas aqueous extracts suppress the development of Aspergillus flavus. Some people in Nigeria use T. procumbens as a green feed for chickens.

Methods

Plants create phytochemicals, which are secondary metabolites, to protect themselves. The bulk of them have pharmacological action. Plant components include alkaloids, cyanogenic glycosides, steroids, tannins, saponins, flavonoids, and phenylpropanoids, among others. The complete potential of secondary metabolites has not been fully realised as of yet. Medicinal plants' potent therapeutic effects are the result of the synergistic action of their many phytochemical components. Consequently, quantitative and qualitative phytochemical analysis of medicinal plants is necessary for their standardisation.

After the leaves of the Tridax Daisy (TD) were dried using the cold maceration method, they were extracted using a sequential extraction procedure. The extracts were subsequently subjected to preliminary phytochemical analysis. Before settling on a particular plant extraction, a battery of in vitro and in vivo studies were conducted to evaluate the various extracts.

Collection of plant material

The abundant woodlands of the Tirupathi district in Andhra Pradesh provided us with the Tridax daisies L. (Daisy) plant. In February of 2022, the newly harvested leaves were dried and ground into a coarse powder.As of this writing, the Tridax daisy has been verified as L by Dr. Madhava Shetty of Sri Venkateswara University in Tirupati, Andhra Pradesh. The authentication certificate number is AGI/2022/3324. In the shade, the leaves were rapidly rinsed and dried. After drying, the fine powder was stored in a sealed plastic container for future use. For the sake of the experiment, we used only leaves that were at least two years old. We removed any leaves that were overripe or still partially unopened. We used distilled water to wash the plants, let them dry in the shade until they were at room temperature, and then ground them into a powder.

Fig 1: Images of Tridax daisy. L. (Daisy)

Statistical analysis

We used Student's t-test to statistically analyse the data, which were presented as mean ± SD. Results were deemed statistically significant when the p-value was less than or equal to 0.05, and extremely significant when it was less than or equal to 0.01.

RESULTS & DISCUSSIONS

Yield of extracts

The yield of extracts of the selected plant was given below:

Tridax daisy. L. Leaves

Water Extract	- 45.89 g
Hexane Extract	- 15.64 g
Ethyl acetate Extract	- 20.43 g
Pet. Ether extract	- 28.46 g
Methanol Extract	- 20.15 g
Ethanol Extract	- 14.37 g

This study is examining the effects of an extract from the leaves of the Tridax daisy Linn. plant. Table 1 displays the results of the phytochemical analysis of the Tridax daisy Linn leaves. No tannin, anthocyanin, emodin, protein, phytosterol, phlobatannin, leuco-anthocyanin, or cardial glycosides were detected in the Tridax daisy Linn leaves, but steroids, saponins, coumarins, alkaloids, amino acids, diterpenes, phenol, or flavonoids were. An ethanol extract of Tridax daisy Linn leaves contained tannin, anthocyanin, coumarins, alkaloids, diterpenes, phenol, and flavonoids; however, it did not contain emodins, proteins, amino acids, phytosterol, phlobatannin, leuco-anthocyanin, or cardial glycosides. The following compounds were identified in Tridax daisy linn leaves: phenol, coumarins, anthocyanin, tannin, alkaloids, amino acids, diterpenes, phenol, and phlobatannin; however, emodins, proteins, phytosterol, leuco-anthocyanin, cardial glycosides, and flavonoids were not.

Ikewuchi Jude et al. (2009) counted six phytochemicals in Tridax procumbens Linn. leaves. Ayyappa Das et al. (2009) determined eight secondary metabolites from the aqueous and methanolic leaf extract of Tridax daisy Linn. Alkaloids, tannins, saponins, steroids, phlobatannins, terpenoids, and flavonoids are among the eight phytochemicals found in the leaves of T. procumbens Linn, as reported by Dhanabalan et al. (2008).

Table 3: Phytochemical test for *Tridax daisy* Linn

Phytochemical test	Extractions					
	Water	**Hexane**	**Ethyl acetate**	**Pet. ether**	**Methanol**	**Ethanol**
Carbohydrates						
Molish's test	+	+	+	-	-	-
Fehling's test	+	-	-	+	-	-
Barfoed's test	+	-	-	-	-	-
Benedicts's test	+	+	+	-	-	-
Proteins &Amino acids						
Millions test	+	-	+	+	+	+
Biurette test	+	-	+	-	-	+
Ninhydrin test	+	-	-	+	+	+
Fats &fixed oils						
Saponification test	-	-	-	-	-	-
DETECTION OF SECONDARY METABOLITIES						
Alkaloids						
Mayers test	+	-	-	+	-	-
Wagners test	+	-	-	-	-	-
Dragondroffs test	+	-	-	-	-	-
Hagers test	+	-	+	+	+	-
Steroids & terpenoid's						
Libermann-Burchard's Test	+	+	+	+	+	+
Salkowsky's Test	+	-	-	-	+	+
Phenolic compounds & Tannins						
Ferric Chloride Test	-	-	-	+	-	-
Lead Acetate Test	+	+	+	+	+	+
Bromine water test	+	-	+	-	-	+
Flavonoids						
Shinoda test	+	-	+	-	+	+
Alkaline reagent test	+	-	+	-	+	+
Saponin Glycosides						
Foam test	-	+	-	-	-	-
Glycosides						
Borntrager's Test	-	-	-	-	-	-
Keller-Killiani Test	+	-	-	+	+	+

(+) denotes presence and (-) denotes absence

The results of a phytochemical examination are among the most reliable indicators of a medicinal plant's quality. The phytochemicals discovered in the water extracts of Tridax daisies include steroids, flavonoids, anthocyanins, alkaloids, terpenoids, glycosides, tannins, saponins, and glycosides. L. O. Because it contains phytochemicals, this plant is highly likely to have medicinal use. Various alkaloids and terpenoids derived from medicinal plants have been discovered to possess anti-inflammatory, antimalarial, anticancer, and antibacterial characteristics. Similarly, steroids generated from plants have antimicrobial and insecticidal properties in addition to cardio-tonic effects. Researchers have found that tannins can inhibit the growth of cancer cells and viruses. Studies on the immunomodulatory and antioxidant effects of glycosides and flavonoids, among other phytochemicals, have been conducted. Upon analysis of the plant parts, we identified a diverse array of molecules. These compounds were subsequently separated and evaluated for their potential to promote wound healing. The phytochemicals found in Tridax daisies determine the plant's potential biological properties. This is the first instance that I am aware of (leaves).

In Vitro Evaluation of Antioxidant Activity

The antioxidant and free radical scavenging activities of several Tridax daisy L. extracts were evaluated using DPPH and Nitric Oxide, two popular free radical scavenging protocols.

Preformulation Studies

Ultraviolet (UV) spectrum

In order to produce the pharmaceutical, preformulation studies need to provide an analytical method for predicting drug concentrations. In India, Tridax daisy. L has a history of usage as an anticoagulant, antifungal, and insect repellant. It has also been found to aid in wound healing. Traditional Indian medicine makes use of the Tridax daisy for the treatment of wounds, boils, and blisters. The abundance of unsaturated bonds in the Tridax daisy molecule causes its spectrum to fall between the 200 to 400 nm range. The UV absorption spectra of Tridax daisy L in ethanol and buffer containing 1 percent SLS was reported to be 229 and 226nm, respectively [432].water and buffers containing 1% sodium lauryl sulphate (SLS) are displayed in Figure 1. Absorption maximum (max) of Tridax daisy. L in.

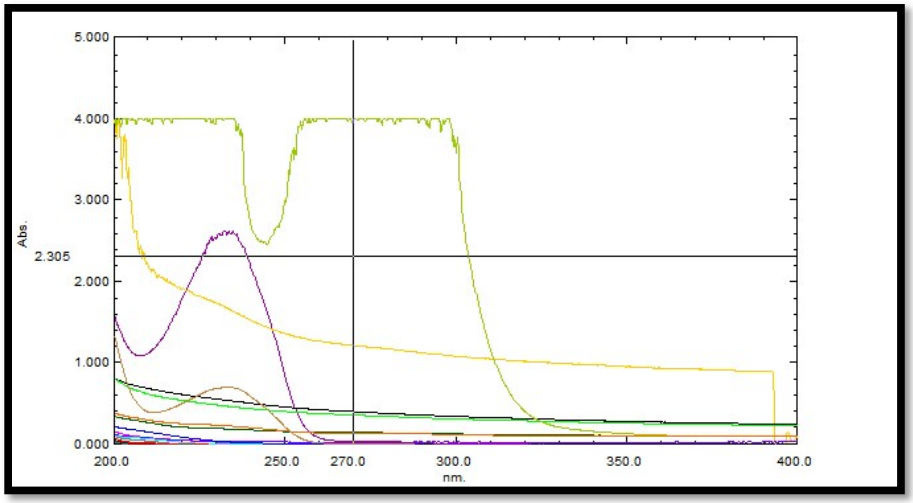

Fig 2: UV scan of Tridax daisy. L in different solvents

Prior to beginning the development of the formulation, the physiochemical properties of the medicinal molecule were examined. We developed a new analytical technique for use in formulation, in vitro, and animal research. During the formulation development process, these investigations help find and fix flaws. The creation of effective pharmaceuticals and their derivatives depends on these studies.

UV-Visible Spectroscopy

As a phosphate buffer, UV spectroscopy helps determine the medication's peak maxima at a given wavelength, which is useful for assessing the sample's purity. This scan confirms that the measured maximum absorption wavelength (232 nm) for the extract in the reference literature is consistent with the calculated maximum absorption wavelength (229 nm) for the drug in a pH 7.4 buffer solution (1% v/v). As a result, the drug's purity may be verified (Fig. 3).

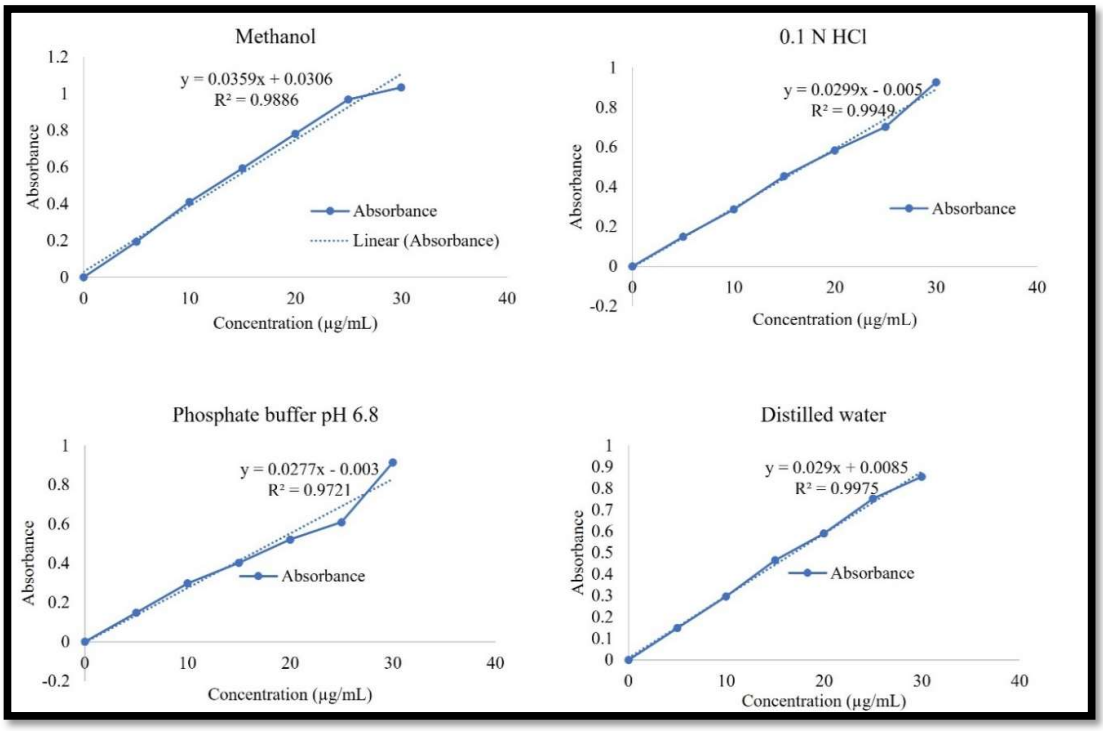

Fig 3: Calibration cure of Tridax daisy. L on different mediums

The method was applicable for concentrations of Tridax daisies ranging from 2 to 10 g/mL, as it was in accordance with Beer's law. The liquid leaf extract from a number of different sample combinations. A correlation coefficient of 0.995 was found between the aqueous extract content and the corresponding absorbance readings, indicating a positive relationship. Here is the equation that shows the concentration-to-absorbance relationship:

Y= 0.0966x-0.1292

Where

y is the 229 nm absorbance and x is the Tridax daisy concentration. concentration of aqueous extract of L.

Solubility

You can get leaf extracts that dissolve well in water, dimethyl sulfoxide (DMSO), and buffer solutions ranging from 1 to 7. The leaf extract did not dissolve in the following solvents: ether, pet, n-Butanol, chloroform, ethanol, or diethyl ether. Dissolves somewhat in ether but not water. [7]

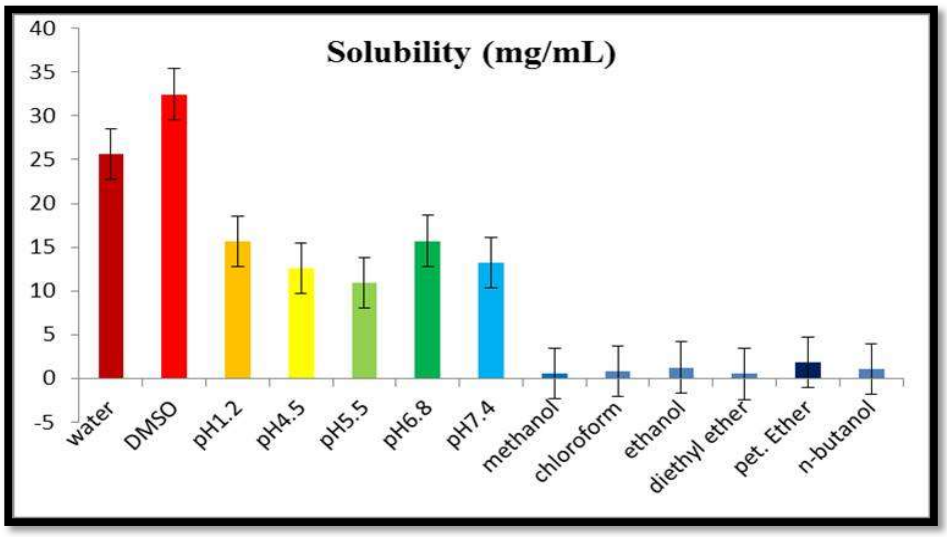

Fig 4: Solubility determination of leaf extract with different solvents

Melting Point

Through the use of the capillary fusion method, the drug's melting point was determined. It was determined that the drug's melting point fell within the reference value range. A table displaying the values is provided. Tridax daisy. L. had an observed melting point of 283.171±1.59 0C, as determined by the glass capillary method using the melting point equipment. L. was verified using the Tridax daisy's normal melting point. The temperature range specified in the literature for L. (280-2850C).

Table 4: Melting Point of Tridax daisy. L.

Apparatus	Observed value	Reference Value
Melting point apparatus	283.171±1.59 ^{0}C	280-285^{0}C

Preparation of solid lipid nanoparticles

Using a heat homogeneity followed by ultrasound treatment technique and three different amounts of solid lipid, this work synthesised Tridax daisy. L. loaded SLNs. The sonication period was fine-tuned to 5 minutes for particles of a certain size and 10 minutes for those with a more uniform dispersion. Because the dimensions of the particles could not change noticeably with increased stirring rates, we were unable to detect a significant shift in the particles size beyond this point. In addition, according to Mehnert and Mäder (2001), the SLNs formulations were found to have uniformly sized particles since the obtained variability indices were all within the permitted range of less than 0.3.[8]

Table 5: Characterization of formulations

F.Code	%EE	%DC	Particle size	Zeta	PDI
SLN-1	68.54±1.02	98.36±0.05	285.61±2.64	-26.35±0.31	0.426±0.02
SLN-2	72.51±1.34	96.34±0.24	235.41±3.15	-20.14±0.24	0.351±0.01
SLN-3	69.23±1.22	95.98±0.13	198.52±4.16	-23.59±0.51	0.284±0.11
SLN-4	59.86±1.42	96.84±0.26	167.49±2.13	-22.41±0.16	0.357±0.03
SLN-5	68.57±1.06	95.02±0.14	182.54±2.05	-16.85±0.38	0.216±0.01
SLN-6	70.41±1.05	94.53±0.31	234.51±3.09	-17.54±0.52	0.286±0.22

Measurement of particle size, PDI and Zeta potential of SLN

The zeta potential, particle size distribution, and PDI values of all the produced formulations were calculated. All of the formulations had an average size that varied between 167.49±2.13 nm and 285.61±2.64 nm. The small size distribution was shown by the PDI, which ranged from 0.216±0.01 to 0.426±0.02. The length of the triglyceride's alkyl chain was a good predictor of the particle size; larger chains had longer particle sizes. The addition of Tridax daisy L. to the SLNs formulations caused a negative surface charge, indicating that the medication was oriented within the lipid matrix. The stability of colloidal dispersion is greatly influenced by the surface charge. For the SLNs formulations tested here, the zeta potential values ranged from -16.85±0.38 mV to -26.35±0.31 mV. Electrostatic stabilisation requires a zeta potential of -30 mV, which is currently acknowledged. Electrostatic repulsion and the steric stabiliser both contributed to the stability of the SLNs dispersion, as shown in numerous tests. The formulation included the stabilising agent Poloxamer 407. After the nanoparticles were sterically stabilised, this non-ionic surfactant formed a coating across their surface to reduce electrostatic repulsion and keep the SLNs stable. Because SLNs stabilised by an assortment of surfactants were found to have better storage stability and lower particle size than formulations stabilised with a single surfactant, the formulations used a surfactant mixture consisting of GMS, poloxamer 188, and tween 80.[9]

Determination of entrapment efficiency and drug content

A range of 94.53±0.31 to 98.36±0.05% was discovered for the total amount of medication in the SLNs formulations. The results showed that the SLNs formulations had an entrapment efficiency ranging from 59.86±1.42 to 72.51±1.34%. The medicine was effectively encased in triglyceride nanoparticles because to the strong lipophilicity in of Tridax daisy. L. One possible explanation is that the glyceride's long-chain fatty acids make it a better vehicle for lipophilic medications. Imperfections caused by the less organised lipid matrix allowed drug molecules to become stranded in empty regions. The drug was dissolved in molten lipid at a temperature higher than the lipid's melting point in this manufacturing process; neither the drug nor any of its precipitates leaked out. The first pass metabolism can be circumvented when a large quantity of a medication is encapsulated in lipid nanoparticles and transported via lymphatic transport.[10]

One way to measure the dispersion of particles is with the polydispersity index, or PDI. No matter the surfactant or lipid type, the PDI values were less than 0.3 in every formulation. This points to a small range of sizes, which is indicative of an appropriate preparation procedure (Bahari & Hamishehkar, 2016).

Fourier Transform Infrared Spectroscopy (FTIR) Analysis

The stability of the crystalline shield of the microemulsion is confirmed by FTIR, a secondary investigation. In the illustration, you can see Tridax daisy, pure extract, oil, surfactant, and physical mixtures. Discovered in the aqueous extract spectra were the stretching of C-OH bonds at 3200.09-3046.04 cm1, C-N bonds at 1510.28-1451.28 cm1, and C-F bonds at 1587.44-1451.28 cm1. The gel and microemulsion were filled with the letter L. The infrared spectrum made the oil's C=O absorption band at 1700 cm1 quite apparent. [11]

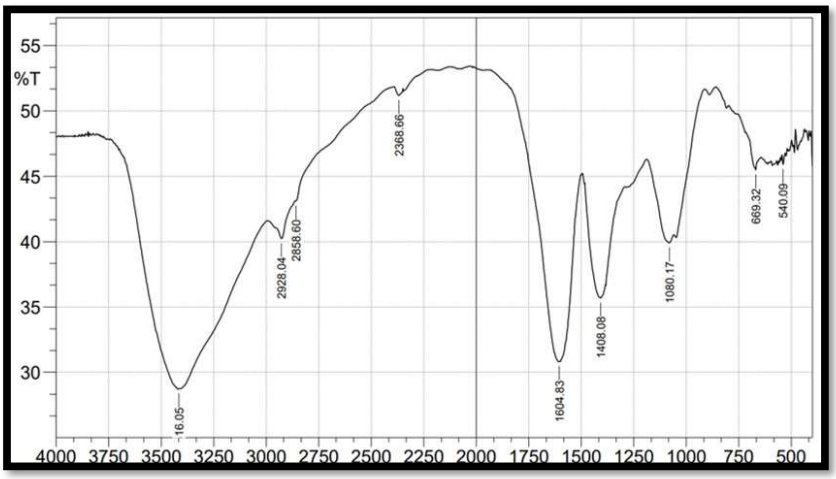

Fig 5: FTIR spectrum of Pure extract

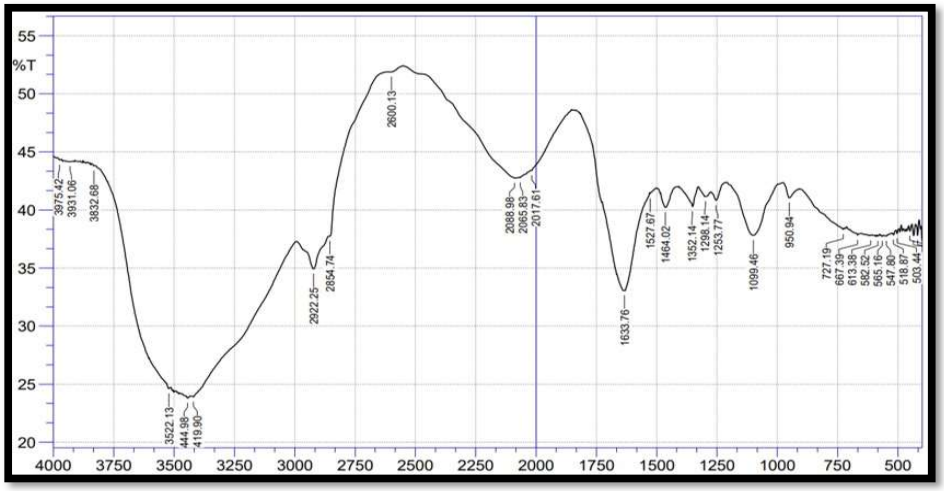

Fig 6: FTIR spectrupm of solid lipid

The majority of the FTIR spectra were missing from the micro emulsion formulation, with the exception of the C=C aromatic and C=C hydrophobic bands at 1618.89 cm-1 and 1281.86 cm-1, respectively, which correspond to C-N aryl groups. Fig. 6.19 shows that the surfactant exhibited four separate peaks: the C-H bend, which occurred at 1466.1 cm-1, and the C-H stretches at 2918.5, 2918, and 1702.5, respectively. This problem may have originated from the dispersion of drug molecules in the formulation, which may have been caused by high temperatures that were present during formulation development. The microemulsion and physical makeup of Tridax daisy are different from those of surfactant. FTIR spectra of L and co-surfactant indicated little interaction, since the drug's distinctive peaks were mostly preserved. [12]

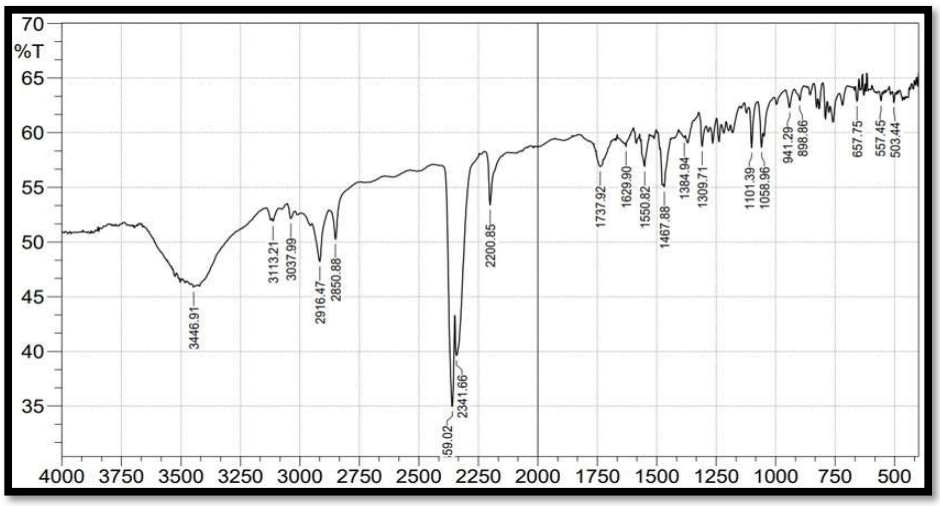

Fig 7: FTIR spectrum optimized solid lipid nanoparticles.

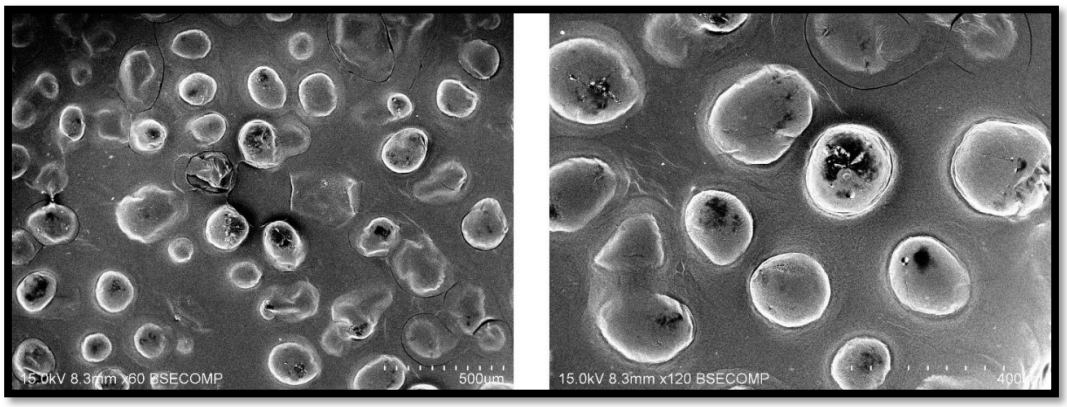

Fig 8: SEM image of optimized SLNs formulation

The surface morphology of the SLNs formulation was examined using scanning electron microscopy at magnifications of 10 k, 15 k, and 20 k. Figure shows that when the particle size rose due to the lyophilization procedure, the agglomeration phenomena became more pronounced, despite the particles' smooth surfaces and spherical shapes.

In vitro drug release study

Figure 4A and Figure 4B show the results of the in vitro drug release experiments conducted using Tridax daisy. L. loaded SLNs and drug suspensions in 0.1 N HCl (1% SLS) and PBS pH 6.8 (1% SLS), respectively. This could be because Tridax daisy L. is more soluble at low pH values, as the drug release from SLNs in 0.1 N HCl (1% SLS) within 2 hours was 8.69 ± 1.39 % higher than in PBS pH 6.8 (1% SLS). The drug released from the suspension in PBS pH 6.8 (1% SLS) was nearly 100% in 6 hours, as demonstrated in Fig. 4B. This release was more rapid, higher, and complete than the drug released from the SLNs formulation. The delayed release of Tridax daisy L. from SLNs in the GI tract was confirmed by the drug release from the formulation after 24 hours, which was 68.54 ±2.86%, and within 8 hours, it was only 34.26 ±0.95%. After oral administration, the enterocytes might absorb the SLNs, which would be favourable for achieving the intended therapeutic effect, due to the minimal drug release of Tridax daisy L. from the SLNs.[13]

CONCLUSIONS

The experimental work carried out following final conclusions can be One potential use for SLN is as a novel nano lipid formulation that is safe for patients to use orally in order to deliver the chosen medications. the Tridax daisy. A promising strategy for increasing its oral bioavailability, L. loaded SLNs show promise as a woodhealing treatment. Reduction in the cost is possible due to better bioavailability and reduction of dose. Improving the bioavailability of medications can be achieved by expanding the notion of intestinal lymphatic uptake utilising a new lipid-based drug nanocarrier. The formulation's lipid content shows promise for the creation

of medicinal formulations that can be delivered orally. One potential alternative to the current oral dose forms that is new, cost-efficient, industrially scalable, and successful is the development of lipid-based nanocarriers for medicines that undergo considerable pre-systemic hepatic metabolism.

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