

ANTIHYPERTENSIVE ACTIVITY OF NANOPARTICLES USING HERB ECLIPTA ALBA ON MALE SPRAGUE DAWLEY RATS

Padmavathi Sakinala¹, Padmaja Vellaturi, Aravapalli Tanusri²,

Pannamareddy Harshita Reddy, Prattipati Beulah

- 1. Professor & HOD, Department of Pharmaceutical Chemistry & Phytochemistry,
Nirmala College of Pharmacy, Atmakur, Mangalagiri,
Andhra Pradesh, Guntur, AP, INDIA**
- 2. Assistant Professor, Department of Pharmaceutical Analysis,
Nirmala College of Pharmacy, Mangalagiri, Guntur, AP, INDIA**
- 3. Student PharmD, Nirmala College of Pharmacy,
Atmakur, Mangalagiri, Andhra Pradesh, Guntur, AP, INDIA**
- 4. PH.D Research scholar, KL University, Veddeswaram, Guntur -522503
KL University, Vijayawada, AP, INDIA.**

ABSTRACT

Eclipta alba is an herbaceous annual plant that has several medical purposes, such as analgesic and vasodilatory effects. Its ability to dilate blood vessels allows it to control blood pressure within them. As a result, it helps to control hypertension. The condition hypertension is last longing disorder. It must be taken carefully and released gradually. With a particle size of less than 500 nm, nanoparticles were the most practicable dose form for a lasting effect. More absorption is made possible as a result, increasing the formulation's bioavailability. Three months after transplantation, or during the early flowering stage, Eclipta alba is picked and gathered. The plant material is then shade dried for approximately ten days, or until the leaves are completely dry. The nanoparticles were prepared by means of solvent evaporation. Chitosan and medicine powder are mixed in the proper solvents to form an emulsion, which is sonicated for about ten minutes before being exposed to a surfactant. Magnetic stirring is used to evaporate the solvent and produce a dispersion. The resultant dispersion is put on a slide and its nanoparticle content is examined. Centrifugation is employed to get the final dispersion after characterizing the nanoparticles. After being collected and dissolved in saline, the solid nanoparticles were administered to the male Sprague Dawley rats in order to evaluate their antihypertensive properties. The mean, diastolic, and systolic arterial pressures were estimated. They are in the normal levels as compared to the standard values hence the prepared herbal nanoparticles of Eclipta alba is proved as drug of choice for the treatment of hypertension.

KEY WORDS: Eclipta Alba, Nano particles, Preparation, Animal activity, Evaluation tests

INTRODUCTION

NANOPARTICLES -A NOVEL DOSAGE FORM

Nanoparticles are sub-ionized, colloidal structures, composed of synthetic polymers and the size ranges form 10-1000 nm. These are novel dosage forms where the drugs are easily dissolved, encapsulated or attached to a nanoparticle medium. The ideal characteristics include nontoxic, sterilizable materials, unique physical and chemical properties ,high therapeutic value , light absorption, and scattering ability and high mobility Advantages include increased solubility, tunable properties ,targeted drug delivery, sustained drug release, good bio-compatibility, bioavailability and biodegradability, decrease toxicity, reduce dosage frequency and enhance therapeutic compliance¹. Disadvantages includes lack of knowledge about nanoparticles, effect on biochemical pathways, varying pharmacokinetic properties, higher cost, limited solubility capacity and potential hazardous effects due to accumulation during half life.

HYPERTENSION

When the blood vessels systolic pressure exceeds 140 mm Hg and diastolic pressure exceeds 90 mm Hg, the ailment is called as hypertension. Genetics advanced age, obesity, sedentary lifestyle, excessive salt consumption and alcohol misuse are causes for hypertension. The majority of people don’t have symptoms, but some people do have severe headaches, blurred visions, chest pain and other symptoms. The best method to determine the hypertension is to examine the blood pressure².

As per the epidemiology reports, worldwide 1.28 billion adults between the ages of 30 and 79 will suffer from hypertension, those who live in low and middle income nation. Around less than half of adults with hypertension receive a diagnosis and treatment but 46% of them are ignorant of their illness. Nearby 1in 5 adults (21%) have controlled hypertension³.

PLANT BIBIOGRAPHY



ECLIPTA ALBA

PLANT PROFILE

Kingdom	-	Plantae
Subkingdom	-	Division
Subdivision	-	Spermatophytina
Class	-	Magnoliopsida
Superorder	-	Asteranae
Order	-	Asterales
Family	-	Asteraceae
Genus	-	Eclipta
Species	-	Eclipta alba

GEOGRAPHICAL DISTRIBUTION: It is well known traditionally acclaimed medicinal herb grown in all regions.

MACROSCOPIC CHARACTERISTICS: Eclipta alba is a small multibranched herbaceous plant grown annual belongs to the Asteraceae family. Especially grown in Asia, Africa, South America which tropical and subtropical regions .

- **Synonym:** False daisy, Bhringraj
- **Colour:** Leaves are dark green, Flowers are white, Stems are reddish brown in colour
- **Size:** Leaves are 4-10 cm long, 0.8-2 cm wide.
- **Height:** Grows up to 90 cm with slender, stiff hairs, reddish stems, rooting at the lower ends

MICROSCOPIC CHARACTERISTICS: The microscopical characteristics of *Eclipta alba* comprises of -Upper epidermis, Palisade cells, Collenchyma, Spongy parenchyma, vascular bundles, Glandular trichome, Lower epidermis

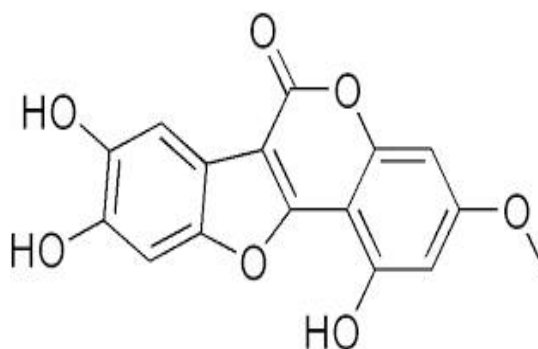
CHEMICAL COMPOSITION OF BHRINGRAJ

Eclipta alba consists of various phytoconstituents which includes - coumestans, alkaloids, flavonoids, glycosides, polyacetylenes, triterpenoids, phenolic acids, saponins, sesquiterpene lactones, proteins and carbohydrates, etc.,

CHEMICAL CONSTITUENTS AND PHARMACOLOGICAL ACTIVITIES

- The principle constituents include coumestan derivatives such as Wedololactone, Dimethyl wedololactone and Desmethyl-wedololactone-7 glucoside, ecliptal, β -amyrin, luteolin-7-O-glucoside, hentriacontanol, heptacosanol, stigmasterol.⁵
- The important chemical constituent responsible for the antihypertensive activity is **wedololactone**.

WEDOLOLACTONE



1,8,9- Trihydroxy -3- methoxy-6H -(3,2-c) (1) benzopyran -6-one

- Wedololactone acts by upregulating PPAR – α and activating AMP – activated protein kinase, inhibiting cyclin D1 and cyclin-dependent kinase inhibitor p21 in balloon-injured common carotid arteries.
- Wedololactone exhibits various pharmacological effects including Antihypertensive activity, Hepatoprotective activity, Antioxidant activity, Hair growth promoting activity, Analgesic activity, Anticancer activity, Antibacterial activity, Antiviral activity, Antifungal activity, Spasmogenic activity

SOXHELEATION PROCESS

DISTILLATION PROCESS:

Distillation is the process of separation of two liquids i.e., volatile substances from Non-volatile substances. The process involves heating which tends to evaporate the solvent. It also involves condensation process which convert the vapours into droplets thereby also removes impurities. After distillation the evaporation of solvent is required because solvent may show unintended effects.

PHYTOCHEMICAL SCREENING

S.NO	PHYTOCHEMICALS	PRESENCE OR ABSENCE
1	Carbohydrates	++
2	Alkaloids	++

3	Amino acids	--
4	Proteins	++
5	Saponins	++
6	Glycosides	--
7	Phenolic compounds	++
8	Steroids	--
9	Tannins	++

MATERIALS AND METHODS

MATERIALS:

The materials used in the nanoparticle formulation includes:

- **Chitosan** is used as a polymer since it is a linear polysaccharide composed of subunits N-acetyl D-glucosamine and D-glucosamine. Chitosan dissolves in acidic pH i.e., below 6.5. Hence it is used as nanocarrier for controlled delivery of therapeutic molecules⁶.
- **Glacial acetic acid** is a solvent also called as anhydrous acetic acid which containing very less amount of water proportion almost less than 1%, colorless organic liquid, cost effective, do not cause any hazardous effects in low concentrations.
- **Ethyl acetate** is an organic solvent used for the solubilization of the powdered drug. It is the most suitable solvent for the nanoparticles formulation because it shows more compatibility for controlled drug delivery compared to many solvents like dichloromethane and chloroform.
- **Sodium lauryl sulphate** used as a surfactant for the complete mixing of two solutions.

PREPARATION AND FORMULATION OF NANOPARTICLES USING SOLVENT EVAPORATION METHOD

Preparation of polymeric solution:

0.3 gms of chitosan polymer is taken and dissolve it in 2% acetic acid solution and then tend to homogenization for homogenous mixture of polymer

Preparation of drug solution:

The suitable quantity of drug material was taken and dissolved it in ethyl acetate solvent which is compatible for the nanoparticle preparation.

Preparation of emulsifying agent or surfactant:

2% sodium lauryl sulphate solution was taken and which is prepared by taking 2 gms of sodium lauryl sulphate powder and dissolving it in 100ml of purified water

Sonication:

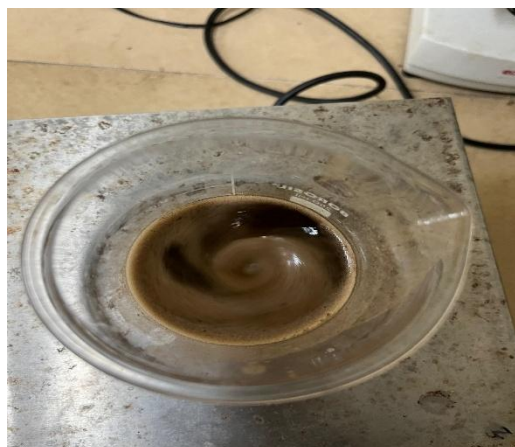
Probe sonicator is used to perform the homogenization process. Ultrasonic homogenization, or probe sonication, is a technique that uses high -frequency sound waves to produce mechanical vibrations. A probe or horn that is submerged in the sample is used to convey these vibrations⁷. Little bubbles form and burst inside the sample as a result of cavitation, which is caused by the energy produced by the sound waves. A more homogenous and uniform sample is produced as a result of disruption and breakdown of particles caused by this cavitation probe sonicator use three components to shake up particles:

- an electronic pulse generator,
- a converter that converts the electrical pulses into mechanical vibrations; and
- a probe or horn that sits inside the sample and transfers the vibrations to it.

Polymer and drug solutions homogenized and probed for sonication using sodium lauryl sulphate solution

Magnetic stirring:

Magnetic stirring used to reduce particle size at 1200-1400rpm



Working: Principles of attraction and repulsion govern the stirring process. Micromotor drives a magnet to produce a revolving magnetic field. Temperature control system ensures the mixture meets experiment requirements

Microscopy Microscope examined to observe prepared nanoparticles. Microscope used to determine particle size and characterize nanoparticles



Centrifugation:

Centrifugation converts nanoparticle dispersion into solid nanoparticles. Sedimentation principle used to separate suspended particles from fluids due to gravity. Sedimental residue collected and evaluated for animal activity and characterization.

FORMULATION OF ECLIPTA NANOPARTICLES

INGREDIENTS	FORMULATION 1	FORMULATION 2
Chitosan {polymer}	300 mg	300 mg
Eclipta powder{drug}	300 mg	500 mg
Ethyl acetate {drug solvent}	10 ml	20 ml
Glacial acetic acid{polymer solvent}	10 ml	10 ml
Sodium lauryl sulphate {2%SLS}	50 ml	50 ml

Procedure:

preparation of polymeric solution and drug solution	• chitosan was dissolved in glacial acetic acid and homogenized for 10 mins. • the drug was dissolved in ethyl acetate and homogenized for 10 mins
preparation of homogenic emulsion of polymeric and drug solution	• both the solutions were mixed using sodium lauryl sulphate as surfactant and homogenized for 10 mins
After homogenization subjected to magnetic stirring	• The obtained solution is subjected to magnetic stirring at 1200 rpm to 1500 rpm and characterization of nanoparticles are done using microscopy.

ANIMAL ACTIVITY

PROCEDURE:

Rats, specifically male Sprague dawley rats, are used as the animal model and are grouped into five groups, each with six individuals. These five groups consist of one standard group, one control group, one normal group, and two test groups—one for a low dose and the other for a high dose. The trial will last for four weeks. The prepared medicine is administered in the fifth week. A non-invasive blood pressure system for rodents was utilized to record any changes in blood pressure. Deoxycorticosterone acetate, or DOPA, was administered at a dose of 20 mg/kg to produce hypertension in the rats. Standard group prazosin was induced at a dose of 1 mg/kg. The hypertension is measured at respective time intervals i.e., for every 3 hours. By these we can calculate the mean arterial pressure, systolic and diastolic blood pressure.

PARAMETERS MEASURED:

Parameters used are systolic blood pressure, diastolic blood pressure, mean blood pressure

DRUGS USED IN THE ANIMAL ACTIVITY:

DRUG	DOSE	ROUTE OF ADMINISTRATION
Deoxycorticosterone acetate	20 mg/kg	Subcutaneously
Prazosin	1mg/kg	Orally
Test drug nanoparticles	1 mg/kg	Subcutaneously

RESULTS**ANIMAL ACTIVITY:****Systolic blood pressure**

Treatment	3 hrs	6hrs	9hrs	12hrs	18hrs	24hrs
Normal	113.42, 114.23, 113.32, 116.32, 117.27, 118.32	111.21, 111.31, 114.23, 117.82, 118.22, 119.32	116.72, 117.32, 118.24, 119.32, 120.12, 119.32	107.43, 108.51, 109.32, 110.91, 119.21, 120.12	108.56, 109.21, 110.32, 113.46, 115.61, 116.32	104.52, 106.32, 108.92, 109.43, 110.32, 111.21
Control	145.67, 146.12, 147.12, 148.42, 148.12, 145.61	147.71, 146.81, 142.12, 143.31, 141.12, 142.12	148.63, 149.31, 151.12, 153.12, 155.41, 156.12	161.23, 163.32, 164.12, 166.72, 167.21, 167.12	165.67, 166.21, 168.23, 167.32, 168.32, 169.12	156.32, 157.71, 158.23, 158.21, 161.12, 162.21
Test (Low dose)	132.13, 132.21, 133.54, 136.16, 137.21, 138.12,	135.6, 134.21, 135.16, 137.18, 138.12, 139.21	127.23, 128.21, 129.12, 130.12, 131.21, 133.14	128.31, 127.12, 128.12, 128.98, 127.83, 123.41	131.23, 132.12, 133.41, 141.21, 141.31, 129.21	134.32, 135.43, 137.21, 142.31, 143.12, 139.12
Test (High dose)	125.62, 131.21, 133.32, 134.34, 139.54, 138.21.	127.37, 128.31, 129.32, 128.12, 129.54, 131.56	123.21, 124.12, 126.72, 127.82, 128.92, 129.12	124.51, 125.62, 126.32, 128.22, 124.32, 125.61	119.21, 120.12, 123.41, 124.51, 126.12, 127.32	112.56, 113.21, 114.32, 115.61, 116.62, 117.12
Standard	115.62, 114.12, 113.21, 114.21, 116.21, 117.32.	114.32, 115.21, 116.32, 117.81, 118.12, 119.91	118.93, 119.21, 120.21, 122.31, 123.21, 124.15	112.21, 113.15, 114.21, 115.61, 116.21, 117.21	114.14, 115.21, 116.32, 117.21, 118.12, 119.12	115.32, 116.12, 117.21, 118.32, 118.42, 119.42

MEAN ARTERIAL PRESSURE

Treatment	3 hrs	6hrs	9hrs	12hrs	18hrs	24hrs
Normal	42.23	41.12	45.62	46.98	47.43	49.12
Control	89.32	88.21	87.32	85.98	89.10	83.21
Test (Low dose)	63.42	64.51	67.32	65.21	66.54	68.43
Test (High dose)	52.21	53.43	56.54	55.82	47.62	48.76
Standard	45.67	46.63	47.42	45.13	42.21	43.32

Diastolic blood pressure

Treatment	3 hrs	6hrs	9hrs	12hrs	18hrs	24hrs
Normal	82.12, 83.21, 78.91, 91. 12, 92.32, 82.12	89.91, 82.32, 81.12, 84. 12, 83.42	68.1, 68.91, 69.12, 70.32, 71. 12, 73.21,	69.91, 70.12, 71. 12, 72.23 71.12,	71.12, 73.12 74.21 75.32 72.32 71.12	72.12 73.32 72.12 74.12 76.32 78.91
Control	98.12, 99.12, 93.32, 94.52, 96. 52, 97.52	91.12, 92.21, 93.32, 94.12, 95.63, 94.23	86.32 83.12 84.43 85. 54 86.43 86.53	86.32 87.32 88.65 87.32 88.43 87.32	87.32 85.32 84.43 85.61 86.32 82.21	76.72 78.43 79.41 73.21 74.12 75.32
Test (Low dose)	99.12, 98. 21, 97.32, 94. 32, 98.54, 96.54,	93.21 94.32 95.64 98.71, 98.54, 96.43	77.32 98.32 88. 43 85.32 83.34 82.12	85.42, 86.12 87.32 88.98 89.12	88.72 89.12, 83.12 84.51 88.70 78.12	78.90, 78.92, 76.12, 79.12 80.12 82.32
Test (High dose)	98.52 97.32, 96.72, 98.42, 96.43, 98.12	88.92 83.43 84.54 86.12 87.32 88.54	87.21 88.92 83.32 84.32 86.42 88.61	91.12 89.43 79.45 87.12 88.54 99.32	92.43 95.32 94.12 93.21 94.32 99.61	81.43 88.54 87.43 86.43 85.43 98.32
Standard	87.12 86.32 87.92, 85.32 86.32, 87.61	89.91 91.32 93.21 91.21 78.45, 69.45	67.83, 71.12 67.72, 62.31, 71.21 59.32	65.31 65.32 61.12 58.90 56.78 58.43	62.21 64.21 59.82 53.32 59.92 58.32	63.23 67.12 68.93 69.21 73.13 81.12

EVALUATION TESTS:

1. PARTICLE SIZE:

FORMULATION	PARTICLE SIZE
F1	101.4
	105.8
F2	159.6
	172.3

2. POLYDISPERSITY INDEX:

FORMULATION	POLY DISPERSITY INDEX
F1	0.43
	0.5
F2	0.8
	0.57

3. ZETA POTENTIAL:

FORMULATION	ZETA POTENTIAL
F1	5.3
	6.9
F2	6.53
	8.89

4. ENTRAPMENT EFFICIENCY:

FORMULATION	ENTRAPMENT EFFICIENCY
F1	79.5
	75.23
F2	71.25
	73.48

5. CLARITY TEST:

FORMULATION	CLARITY
F1	CLEAR
	CLEAR
F2	CLEAR
	CLEAR

6. pH:

FORMULATION	pH
F1	6.7
	6.9
F2	6.5
	6.7

7. PERCENTAGE EFFICACY:

Name of Organism	Standard Zone of Inhibition	Test Zone of Inhibition	% Efficacy
Staphylococcus	1.5	1.4	93.33
Bacillus subtilis	1.1	1	90.9
Escherichia coli	1.6	1.5	96.15
Candida albicans	1.9	1.8	96.55

ZOI - ZONE OF INHIBITION**8. DRUG CONTENT:**

FORMULATION	BEFORE	AFTER
F1	86.019	85.64
F2	77.833	77.447

9. GELLING CAPACITY:

FORMULATION	BEFORE	AFTER
F1	+++	+++
F2	+++	+++

10. VISCOSITY:

FORMULATION	BEFORE	AFTER
F1	123	121
F2	128	125

SUMMARY

- Eclipta alba medicinal properties and hypertension management
- Eclipta alba an annual herbaceous plant, has analgesic and vasodilatory effects
- It regulates blood pressure within blood vessels, aiding in hypertension management
- The most practical dose form for prolonged effect is nanoparticles, with a particle size of less than 500 nm
- Eclipta alba is harvested and gathered three months after transplantation, then shade dried for ten days
- Nanoparticles are prepared using solvent evaporation, chitosan and medication powder
- The resulting dispersion is checked for nanoparticles and characterized using centrifugation
- Male Sprague Dawley rats were given solid nanoparticles to test their antihypertensive effects
- Evaluation tests are performed the values are within the IP limit.

CONCLUSION

Using male Sprague dawley rats, parameters such as diastolic and systolic pressure were monitored, and mean arterial pressure was computed. The nanoparticles were assessed using several methods such as zeta potential, polydispersity index, and particle size analysis. The plant is recognized to exhibit antihypertensive activity by carrying out the animal activity. The resulting nanoparticles when conducting the evaluation tests fall within the IP limitations. Therefore, in contrast to the numerous allopathic medications on the market, we determine that the nanoparticles are appropriate for treating hypertension.

Acknowledgement: All are equally contributed the work. My special thanks to the management, principal, Staff of Nirmala college of pharmacy, Atmakur, Mangala Giri.

Conflicts of Interest: All authors are equally contributed the work. There is no conflicts of interest.

REFERENCES:

1. Thenmozhi M, J. M:PHYTOCHEMICAL SCREENING AND ANTIOXIDANT ACTIVITY OF ECLIPTA ALBA:Published in Asian Journal of... 31 January 2019,Medicine, Environmental Science DOI:10.22159/ajpcr.2019.v12i2.27828.
2. Abinash Kumar Sahu, Amiya Ranjan Padhan, Sunanda Badi, SoumitriSahu, Smriti Ranjan Dash, Sujit Kumar Barad, ECLIPTA ALBA: PHYTOCHEMICAL SCREENING WITH IT'S ANTIOXIDANT EFFICACY & ANTHELMINTIC STUDY OF IT'S DIFFERENT EXTRACTS:Published October 19, 2021.
3. John Wyson, Phytochemical Analysis of Leaf Extract of Eclipta alba (L.) Hassk by GC-MS Method, Published 2014: Chemistry, Environmental Science, Medicine.
4. Divyanshu Anand, John Wyson, Phytochemical Analysis of Leaf Extract of Eclipta alba (L.) Hassk by GC-MS Method, International Journal of Pharmacognosy and Phytochemical Research 6(3):562-566: October 2014.
5. MONALISA JENA, EFFECT OF ECLIPTA ALBA ON FRUCTOSE INDUCED HYPERTENSION IN ALBINO RATS:Bhubaneswar, India. Volume 5, supplement 3, 2013.Received: 23 May 2013, Revised and Accepted: 15 Jun 2013.
6. Vasavi Rangineni, D. Sharada, and Saileshnath: Diuretic, Hypotensive, and Hypcholesterolemic Effects of Eclipta alba in Mild Hypertensive Subjects: A Pilot Study:Published Online: 1 May 2007.
7. Kumari, HemlataKaurav, ECLIPTA ALBA (BHRINGRAJ): A PROMISING HEPATOPROTECTIVE AND HAIR GROWTH STIMULATING HERB.Published in Asian Journal of 31 May 2021, DOI:10.22159/ajpcr.2021.v14i7.41569.
8. Goutam Mukhopadhyay, Shymodip Kundu: A review on physicochemical & pharmacological activity of Eclipta alba The Pharma Innovation Journal 2018; 7(9): 78-83: Department of Pharmaceutical Technology, BCDA College of Pharmacy & Technology, Jessore Road(S), Kolkata.
9. Monali Patel, Ramtej Verma and Pranav Srivastav, Antioxidant activity of Eclipta alba extract: Received: 14-07-2016, Accepted: 15-08-2016, Department of Zoology, University School of Sciences, Gujarat University, Ahmedabad- 380009, India.
10. Bawoke Mekuye, BirhanuAbera, Nanomaterials: An overview of synthesis, classification, characterization, and applications:First published: 10 June 2023.
11. Navneet Kumar,Rakesh Kumar: Alcoholic extract of eclipta alba Shows In Vitro Antioxidant and Anticancer Activity without exhibiting Toxicological Effects: Volume: Published 31 Jan 2017.

12. Vinodkumar Nelson, Nalini Kanta Sahoo: In vitro anticancer activity of Eclipta alba whole plant extract on colon cancer cell HCT-116:Published: 23 November 2020.
13. Surendranath Betala, M. Mohan Varma, Formulation and evaluation of polymeric nanoparticles of an antihypertensive drug labetalol: Journal of Drug Delivery and Therapeutics, Journal of Drug Delivery Therapeutics. 2018; 8(6-s):187-191.
14. Sokkalingam Arumugam Dhanaraj, Selvadurai Muralidharan: Formulation and Evaluation of Chitosan Nanospheres Containing Methotrexate Targeted Drug Delivery System: J Young Pharm, 2016; 8(4): 330-334.
15. Seidy Pedroso-Santana, Noralvis Fleitas-Salazar: Ionotropic gelation method in the synthesis of nanoparticles/microparticles for biomedical purposes: Polymer International 69 (5), 443-447, 2020.
16. Sedigheh Vaezifar, Shahnaz Razavi, Effects of some parameters on particle size distribution of chitosan nanoparticles prepared by ionic gelation method: Journal of Cluster Science 24, 891-903, 2013.
17. Veronica Lassalle, María Luján Ferreira: PLA nano-and microparticles for drug delivery: an overview of the methods of preparation: Macromolecular bioscience 7 (6), 767-783, 2007.
18. Karim Miladi, Sana Sfar, Hatem Fessi, Nanoprecipitation process: from particle preparation to in vivo applications: Polymer Nanoparticles for Nanomedicines: A Guide for their Design, Preparation and Development, 17-53, 2016.
19. Rameshwar Deshmukh, Pankaj Wagh, Jitendra Naik: Solvent evaporation and spray drying technique for micro-and nanospheres/particles preparation: A review on Drying technology 34 (15), 1758-1772, 2016.
20. Anam Saeed, Kashif Bashir: Antihypertensive Activity in High Salt-Induced Hypertensive Rats and LC-MS/MS-Based Phytochemical Profiling of Melia azedarach L. Leaves, Biomed research international 2022; 2022: 2791874. Published online 2022 Jul 26. doi: 10.1155/2022/2791874.
21. Claudia Janeth Martínez Rivas, Mohamad Tarhini: Nanoprecipitation process: From encapsulation to drug delivery: International Journal of Pharmaceutics Volume 532, Issue 1, 30 October 2017, Pages 66-81.
22. Ali Jahanban-Esfahlan A simple improved desolvation method for the rapid preparation of albumin nanoparticles: International journal of biological macromolecules: VOLUME 91, October 2016, Pages 703-709.
23. S. padmavathi, V. Nandini A Comprehensive knowledge on the aquasomes novel drug delivery system, journal of cardiovascular disease and research, vol 12, issue 05, 2021
24. Padmavathi sakinala, A Review on hydrogel pharmaceutical preparation, international journal of current advanced research, vol 8, issue 02, page no 17273-17276, feb 2019
25. Padmavathi sakinala, A Review on nanotechnology and its application in the field of pharmacy, Educational administration theory and practice, 30(1) 964-973, 2024-12-28
26. Sakinala Padmavathi, Electrochemical sensors based on conductive polymers and carbon nanotubes, Novyimir research journal, vol 9, issue 8, 2024, page no 23, 2024