WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.63
Volume 15, Issue 12, 774-788. Research Article ISSN 2277–7105

DEVELOPMENT AND EVALUATION OF ADVANCED NANOSPONGES BASED MELOXICAM GEL FOR PROLONGED ANTI-ARTHRITIC ACTIVITY

Tanvi I. Ambhire[1]*, Dr. Avish D. Maru[2], Jayshree S. Bhadane[3]

India.

Article Received on 13 May 2026,
Article Revised on 03 June 2026,
Article Published on 16 June 2026

https://doi.org/10.5281/zenodo.20696749

***Corresponding Author**

Tanvi I. Ambhire

India.

How to cite this Article: Tanvi I. Ambhire[1]*, Dr. Avish D. Maru[2] , Jayshree S. Bhadane[3] (2026). Development And Evaluation Of Advanced Nanosponges Based Meloxicam Gel For Prolonged Anti-Arthritic Activity. World Journal of Pharmaceutical Research, 15(12), 774–788.

ABSTRACT

Recent advances in nanotechnology have led to the development of a targeted drug delivery system. To successfully target a molecule to a target region, however, a specific medicine delivery technique is required. Furthermore, the NS has been used to improve the solubility and rate of dissolution of poorly soluble drugs. Nanosponges with controlled release properties can reduce drug toxicity by improving their stability and half-life. They are a biodegradable, three-dimensional network that releases the drug when the body progressively breaks it down. The NS particles move throughout the body until they arrive at a certain location, stick to surfaces, and begin releasing the drug in a controlled and predictable manner. Nanotechnology and nanomedicines, as a large field of study, offer solutions to a variety of unsolved therapeutic and pharmaceutical difficulties with delivery. Because they prolong the release of pharmaceuticals and solubilize poorly water-soluble drugs, nanosponges are the most widely used dosage form based on nanoparticles. Nanosponges are extremely tiny, nanoscopic particles that resemble sponges and are composed of several drug-filled chambers. Arthritis is an autoimmune disease that causes inflammation in the body's tissue that is damaged. Nanosponge gel may be useful in the treatment of arthritis. It ensures controlled and prolonged drug release in addition to outstanding stability. Because of their aqueous solubility, nanosponges can be used successfully for medications with lowsolubility. To target systems for delivering drugs, nanosponges can be applied topically. When situated side by side, nanosponges porous structure provides it a special capacity to capture drugs and

provide the best release rate. When applied topically, it reaches the site of action, sticks to the receptor site, and releases the drug in a consistent and desirable manner. The components, preparation methods, characterization, and uses as a drug delivery system in the field of nanotechnology are all covered with this study.

KEYWORDS: Meloxicam, Topical Nanosponges formulations, Arthritis management, Drug delivery, Inflammation, Drug encapsulation, Controlled drug release.

INTRODUCTION

Topical drug delivery techniques have proven to be a successful approach of treating arthritis because they allow medication to be delivered directly to the site of inflammation. By improving drug concentration at the impacted joints and decreasing systemic absorption, this targeted delivery reduces gastrointestinal and systemic side effects. Topical medications such as creams, ointments, and gels are commonly used to treat arthritis due to their simplicity of application and patient acceptance. However, traditional topical formulations sometimes need frequent reapplication, have a short duration of action, rapid drug release, and low stratum corneum penetration. New drug delivery techniques that can overcome the limitations of conventional topical formulations have been made possible by recent advancements in nanotechnology. Among these modern techniques, nanosponges received significant attention as an effective way of delivering drugs that are poorly soluble in water. Highly porous, three-dimensional polymeric networks have been created by cross-linking suitable polymers. Their unique sponge-like form allows for the efficient encapsulation of medicinal substances due to its large surface area and internal pores. A nanosponge-based gel formulation serves as a reservoir mechanism, delivering the drug gradually and under control.

Its prolonged release method protects therapeutic drug levels at the site of inflammation, reduces the frequency of dosages, and improves patient adherence to therapy. Arthritis is a chronic inflammatory illness that causes pain, swelling, stiffness, and reduced movement of the joints. Non-steroidal anti-inflammatory drugs (NSAIDs) are commonly used to treat arthritis because of their analgesic and anti-inflammatory characteristics. Oral delivery, however, is associated with gastrointestinal adverse effects, liver damage, and poor patient compliance during long-term treatment. There are several advantages to topical drug delivery systems, such as targeted drug action, fewer systemic side effects, and avoidance of first-pass metabolism. Nanosponges are novel nanocarrier systems composed of cross-linked polymeric networks that can encapsulate hydrophilic and lipophilic drugs.

TYPES OF ARTHRITIS

Osteoarthritis: The most common form of arthritis, osteoarthritis is caused by the cartilage in the joints continuously breaking down. It primarily affects older people and usually affects the hands, knees, and hips. As the cartilage decreases, the bones rub against one another, causing pain, stiffness, and decreased joint movement. It has not been inflammatory and grows gradually over time.

Rheumatoid Arthritis: Rheumatoid arthritis is a chronic autoimmune illness in which the body's immune system attacks the synovial lining of joints. Especially in the morning, this results in pain, stiffness, edema, and inflammation. Symmetrical joints, such both hands or knees, are usually affected. If addressed, it could lead to abnormalities in the joints and loss of function.

Psoriatic Arthritis: Psoriatic arthritis can occur in people who have psoriasis, a skin disease. It causes joint pain, stiffness, and edema in addition to skin symptoms including red, scaly patches. It can affect any joint and cause cracking or thickening of the nails.

Septic Arthritis: The etiology of septic arthritis is a joint infection, usually brought on by bacteria. The results include fever, redness, swelling, and extreme agony. The knee is the most commonly affected joint. It is a medical emergency that requires immediate antibiotic treatment in order to prevent joint damage.

Gout: Increased blood uric acid levels lead to the development of uric acid crystals in the joints, which is a type of arthritis. It usually affects the big toe and is characterized by sudden, severe pain, edema, and redness. Alcohol use, health, and metabolic issues are common contributing factors.

NANOSPONGES GEL

A topical drug delivery method termed nanosponges gel uses nanosponges tiny porous nanoparticles in a gel basis. These nanosponges have the capacity to retain drug molecules within their structure and release them gradually when applied to the skin. This controlled release ensures a sustained therapeutic effect while improving the drug's stability and absorption. Nanosponges gel also lessens adverse effects and skin irritation as compared to conventional formulations. It is widely utilized in dermatological, anti-inflammatory, and pain-relieving treatments.

MATERIALS AND METHODS

MATERIALS

Sr. No.	Chemicals &Reagents	Uses
1	Meloxicam	Active pharmaceutical ingredient
2	Eudragit RS 100	Controlled & sustained drug release
3	Polyvinyl Alcohol	Prevents aggregation & controls particle size
4	Ethanol	Solubilization of drug & polymer
5	Carbopol 934	Gel base formation provide viscosity & consistency
6	Propylene Glycol	Enhance skin penetration
7	Triethanolamine	PH adjustment & gel formation
8	Distilled water	Vehicles

NANOSPONGES GEL FORMULATION METHOD

METHODS

Step1:Organic Phase Preparation

Weigh Meloxicam and Eudragit RS-100 accurately, then dissolve them in ethanol to get a transparent solution.

Step2:Aqueous Phase Preparation

To make a PVA solution, dissolve PVA in distilled water and heat gently.

Step 3: Phase Dispersion

Drop wise add the organic phase to the aqueous PVA solution. Continue stirring with a mechanical stirrer.

Step4: Evaporation & Diffusion of Solvents

At room temperature, keep stirring. Porous nanosponges are created when organic solvent diffuses & evaporates.

Step5: Collecting Nanosponges

Centrifuge the resulting nanosponges. To eliminate any remaining PVA, wash the nanosponges with distilled water, dry them in a hot air oven, and then store them in a desiccator until required again.

Step6: Gel Base Preparation

Carbopol 934 should be dispersed in distilled water. Allow themselves a whole day to stay hydrated. Gradually include meloxicam nanosponges into the hydrated gel foundation while stirring gently. Then add propylene glycol and thoroughly mix.

Step 7: PH Adjustment

Add triethanolamine drop wise until a clear gel forms & adjust pH to 5.5–7.0. Make up the final weight with distilled water & Stir gently to obtain a smooth, homogeneous gel.

Table. Formulation Trials Batch.

Sr No.	Ingredients	F1	F2	F3	F4	F5	F6	F7	F8
1	Meloxicam	100	100	100	100	100	100	100	100
2	Eudragit RS 100	2600	2700	2400	2000	3000	1300	3400	2300
3	Carbopol 934	200	200	200	600	600	600	200	600
4	Sodium CMC	1500	500	1500	1500	500	1500	500	500
5	HPMC	100	1000	300	300	300	1000	300	1000
6	Methanol	1	1	1	1	1	1	1	1
7	Propylene Glycol	300	300	300	300	300	300	300	300
8	Sodium Hydroxide	Q.S	Q.S	Q.S	Q.S	Q.S	Q.S	Q.S	Q.S
9	Polyvinyl Alcohol	200	200	200	200	200	20 0	200	200

EVALUATION OF NANOSPONGES GEL

1.Physical Appearance

The prepared meloxicam loaded nanosponges gel was evaluated visually for color, homogeneity, consistency, and grittiness. The formulation was found to be smooth, homogeneous, and free from lumps.

2.Determination of PH

The pH of the prepared meloxicam loaded nanosponges gel was determined using a calibrated digital pH meter. About 1 g of gel was dispersed in distilled water and the electrode was immersed into the formulation to record the pH.

3. Determination of Viscosity

The viscosity of the prepared gel was measured using Brookfield viscometer at 100 rpm using spindle no. 6. The formulation showed optimum viscosity and good consistency.

4. Determination of Spreadability

Spreadability of the prepared gel was determined by using the glass slide method. A small quantity of gel was placed between two glass slides and a weight was placed over the upper slide. The time taken by the upper slide to move a certain distance was noted. The formulation showed good spreadability, indicating easy and uniform application over the skin surface. The spreadability was then calculated from the following formula.

$S = M \times L / T$

S = Spreadability

M = Mass in grams

L = Length of slide

T = Time

5. Drug Content Determination

An accurately weighed quantity of meloxicam loaded nanosponges gel equivalent to 10 mg of drug was dissolved in suitable solvent and diluted with phosphate buffer pH 6.8. The solution was filtered and analyzed using a UV-Visible spectrophotometer at 365 nm .

6. In-vitro Diffusion Study

The in-vitro drug release study of meloxicam loaded nanosponges gel was carried out using a Franz diffusion cell. An accurately weighed quantity of gel was placed on a dialysis membrane, which was mounted between the donor and receptor compartments. The receptor compartment was filled with phosphate buffer pH 6.8 and maintained under continuous stirring. At predetermined time intervals, samples were withdrawn and replaced with fresh buffer solution. The samples were analyzed using a UV-Visible spectrophotometer at 365 nm.

7. Stability Studies

As per the ICH guidelines, the optimized meloxicam loaded nanosponges gel formulation was stored in a tightly closed container in an ICH certified environmental stability chamber for 30 days. Nanosponges gel was evaluated for PH, drug content & in vitro drug release studies.

Table. Evaluation Tests of Optimised F6 Batch.

Batch	Drug Content (%)	Drug Release (%)	Viscosity
F1	91.5	82.4	4.25
F2	86.2	86.2	3.98
F3	88.5	88.5	3.65
F4	76.8	76.8	6.12
F5	74.5	74.5	6.45
F6	79.3	79.3	5.98
F7	84.6	84.6	4.32
F8	77.2	77.2	6.21

RESULTS AND DISCUSSIONS

PHYSIOCHEMICAL EVALUATION

Preformulation studies are important in the development of meloxicam nanospomges gel for the treatment of arthritis. This studies help to evaluate the physiochemical properties of meloxicam and it is compatability with selected excipients to ensure stability, efficacy and safety of the formulation.

1.Organoleptic properties

Colour	Pale Yellow/ Light Yellow Powder
Odour	Odorless
Apperance	Crystalline Powder
Taste	Slightly Bitter

2.Melting Point

The melting point of meloxicam was determined using a melting point apparatus to confirm the purity and identity of the drug sample. The observed melting point was compared with the reported literature value.

Literature	242°C to 254°C
Observed	245°C

3.Solubility

Calibration curve of Meloxicam in Methanol, Water, 0.1N Hcl , Phosphate Buffer.

UV Absorbance

Sr. No	Preparation (Conc.)	Methanol 365 nm	Water nm	0.1N Hcl nm	Phosphate Buffer
1	0.5	0.192	0.25	0.03	0.118
2	1.0	0.289	0.45	0.25	0.206
3	1.5	0.432	0.355	0.45	0.28
4	2.0	0.578	0.625	0.6	0.419
5	2.5	0.721	0.85	0.754	0.517
6	Unknown (10ug/ml)	0.285	0.470	0.287	0.210

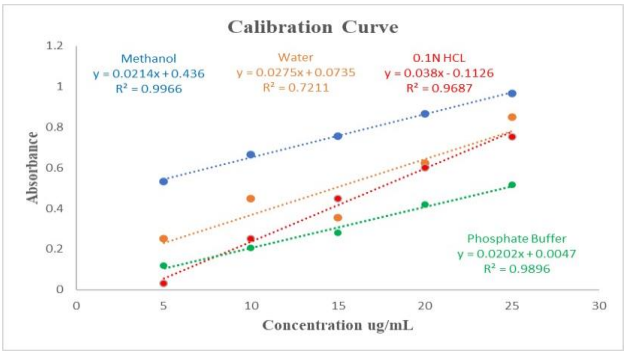

Fig. Solubility Calibration Curve.

4. UV Calibration Curve

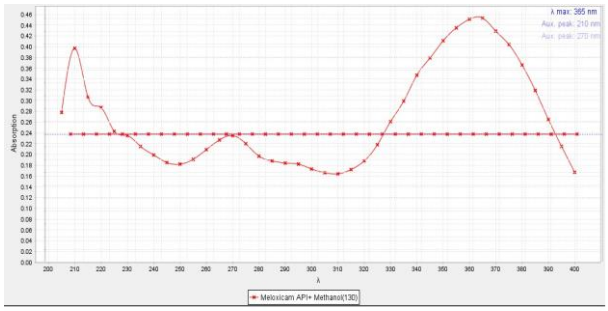

Fig. Determination of λ max in methanol.

When examined in the range 354 nm to 360 nm, a 0.001 percent w/v solution in methanol shows an absorption maximum at about 365 nm.

Concentration and Absorbance for Meloxicam in Water.

Sr No.	Concentration (ug /ml)	Absorbance (λmax 365nm)
1	0.5	0.192
2	1.0	0.289
3	1.5	0.432
4	2.0	0.578
5	2.5	0.721

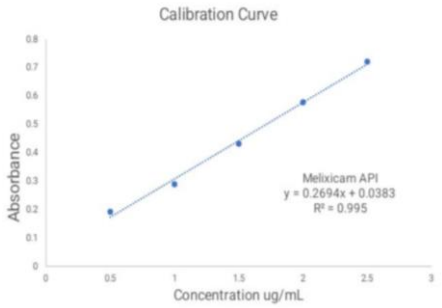

Fig. UV Calibration Curve.

5.PH

The pH of the drug solution/dispersion was determined using a calibrated digital pH meter at room temperature (25 ± 2 °C).The pH of the given sample was found to be 5.5 pH indicating that the sample is slightly acidic in nature.

6.FTIR

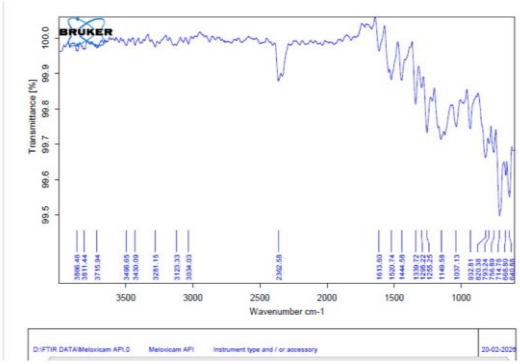

Fig. FTIR Of Meloxicam.

Range of functional group present in FTIR Spectrum Meloxicam.

Sr No.	Frequency cm-^{1}	Functional Group
1	3430 cm-^{1}	N-H Stretching (Amine/ Amide)
2	3034 cm-^{1}	C-H Stretching (Aromatic)
3	1613 cm-^{1}	C=C Stretching (Aromatic Ring)
4	1457 cm-^{1}	C-H Bending (Alkane/Aromatic)
5	1037 cm-^{1}	C-O Stretching (Alvohol/ Ether)

The FTIR investigation was carried out to ensure the identity of pure drug by functional group presentation.

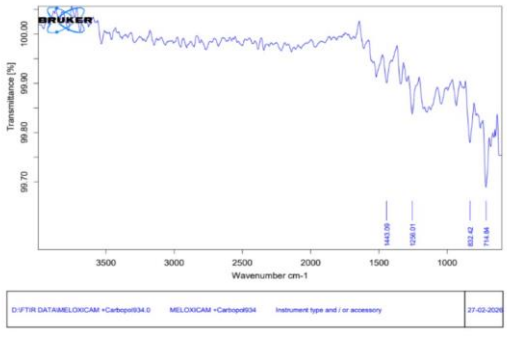

Fig. FTIR Meloxicam + Carbopol 934.

Range of functional group present in FTIR Spectrum Meloxicam+ Carbopol 934.

Sr No.	Frequency cm-^{1}	Functional Group
1	1443.09 cm-^{1}	C-H Bending (Alkane)
2	1256.01 cm-^{1}	C-N Stretching (Amine)
3	832.42 cm-^{1}	Aromatic C-H out of Plane Bending
4	714.84 cm-^{1}	C-H Bending (Alkane)

The FTIR investigation was carried out to ensure the identity of pure drug by functional group presentation.

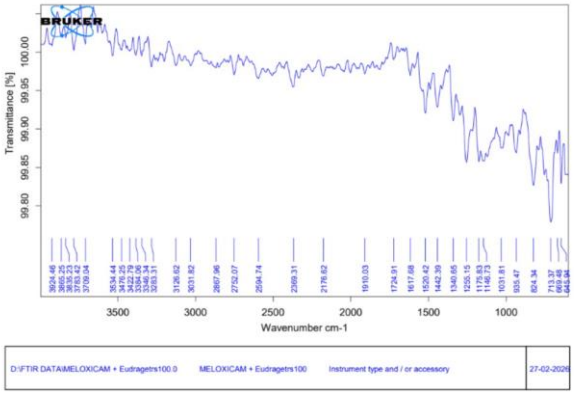

Fig. FTIR Meloxicam + Eudragit RS100.

Range of functional group present in FTIR Spectrum Meloxicam+ Eudragit RS 100.

Sr.No	Frequency cm-^{1}	Functional Group
1	3709 cm-^{1}	O-H Stretching (Free Hydroxyl/Moisture)
2	3283 cm-^{1}	N-H Stretching (Secondary Amine)
3	3126 cm-^{1}	C-H Stretching (Aromatic)
4	1724 cm-^{1}	C=O Stretching (Ester Group -Eudragit)
5	1617 cm-^{1}	C=C Stretching (Aromatic Ring)

The FTIR investigation was carried out to ensure the identity of pure drug by functional group presentation.

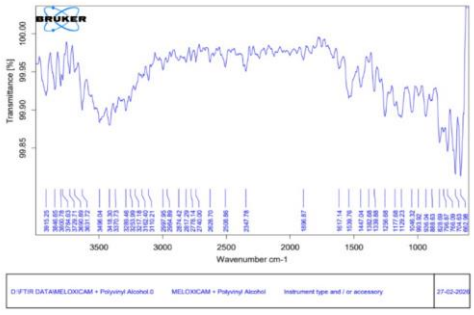

Fig. FTIR Meloxicam + Polyvinyl Alcohol.

Range of functional group present in FTIR Spectrum Meloxicam+ Polyvinyl Alcohol.

Sr No.	Frequency cm^{-1}	Functional Group
1	3640 cm^{-1}	O-H Stretching
2	3300 cm^{-1}	N-H Stretching
3	3100 cm^{-1}	C-H Stretching
4	1539 cm^{-1}	N-H Stretching
5	1325 cm^{-1}	C-N Stretching

The FTIR investigation was carried out to ensure the identity of pure drug by functional group presentation.

7. DSC

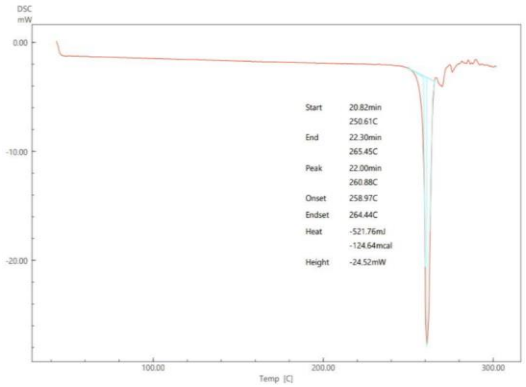

Fig. DSC Of Meloxicam.

The DSC thermogram of pure meloxicam showed a sharp endothermic peak at around 260.88 °C which corresponds to the melting point of meloxicam. The sharp peak confirms the crystalline nature and purity of the drug. The absence of additional peaks indicates that the sample is relatively pure and thermally stable.

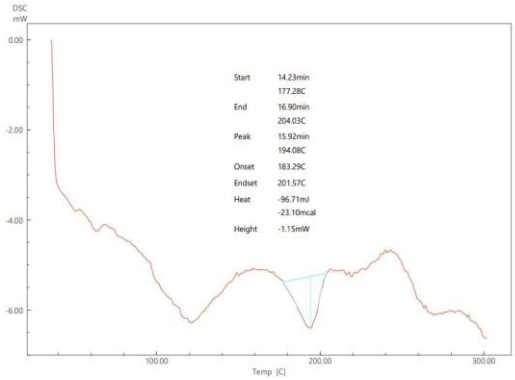

Fig. DSC Of Meloxicam + All Excipient.

The DSC thermogram showed a characteristic endothermic peak at around 194°C, with an onset temperature of approximately 183°C and endset near 201°C. The peak was slightly broadened & shifted compared to pure meloxicam, which suggests interaction of the drug with the polymer matrix containing Eudragit RS100, Carbopol 934 and PVA. The reduction in peak intensity indicates partial reduction in crystallinity and successful incorporation of meloxicam into the formulation. No additional unexpected peaks were observed, indicating compatibility between meloxicam and excipients.

CONCLUSIONS

The present research effectively created and evaluated a gel of meloxicam-loaded nanosponges for the treatment of arthritis. Using Eudragit RS100 polymer and the emulsion solvent diffusion method, the meloxicam-loaded nanosponges gel was effectively created and added to the Carbopol 934 gel foundation. Meloxicam's purity, identity, and compatibility with the selected excipients utilized in the formulation have been verified by preformulation tests such as organoleptic assessment, melting point determination, solubility study, and UV & FTIR compatibility research. The physical appearance, PH, viscosity, spreadability, drug content, and in vitro diffusion studies of the produced nanosponges gel were all satisfying physicochemical characteristics. The creation of stable, nanoscale porous particles was demonstrated by particle size analysis.

Additionally, meloxicam was shown to release steadily and under control with effective skin penetration in the in-vitro drug release investigations. The formulation remained stable without appreciable changes in physicochemical characteristics, according to stability studies conducted under ICH-recommended settings. Overall, by increasing patient compliance, decreasing systemic adverse effects, and optimizing drug delivery, the recommended meloxicam-loaded nanosponges gel may be an appropriate topical nanocarrier system for the treatment of arthritis.

REFERENCES

1. Choy EHS and Panayi GS: Cytokine Pathways and Joint Inflammation in Rheumatoid Arthritis. New Engl. J Med., 2001; 344: 907-16.
2. Patel Ek and Oswal RJ: Nanosponge And Micro Sponges:A Novel Drug Delivery System. IJRPC, 2012; 2(2): 237- 44.
3. Swaminathan S, Darandale S and Vavia PR: Nanosponge-Aided Drug Delivery. A Closer Look. Pharm. Formul. Qual., 2012; 2(7): 12-15.

4. Shinde G, Rajesh Ks, Bhatt D, Bangale G, Umalkar D andVirag G: Current status of colloidal system (nano range).Int. J Drug Formul. Res., 2011; 2(6): 39-54.
5. Salunkhe A, Kadam S, Magar S and Dangare K:Nanosponges: A modern formulation approach in drug delivery system. World J Pharm. Sci., 2018; 7(2): 575-92.
6. Van der Ende AE, Kraviz EJ and Harth E: Approach to Formation of multifunctional polyester particles in controlled nanoscopic dimensions. J Am Chem. Soc., 2008; 130: 8706-13.
7. Swaminathan S, Vavia PR, Trotta F and Torne S:Formulation of betacyclodextrin based nanosponges of Itraconazole. J Incl. Phenom. Macrocyl Chem., 2017; 57: 89-94
8. Indian Pharmacopoeia, 2018; 2: 29.
9. Verma N and Deshwal S: Design and in-vitro evaluation of transdermal Patches containing Ketoprofen. World J Pharm. Res., 2014; 3(3): 3930- 44.
10. Available from: https://en.wikipedia.org/wiki/Nonsteroidal anti-inflammatory drug [Last accessed on July 2021 25th].
11. Kumar AS, Sheri PS and Kuriachan MA: Formulation and Evaluation of Antifungal Nanosponge Loaded Hydrogel for Topical Delivery. Int. J Pharm. Res., 2018; 13 (1): 362-79.
12. Abbas N, Parveen K, Hussain A, Latif S, Zaman SU, Shah PA and Ahsan M: Nanosponge-based hydrogel preparation.
13. Raj PP, Gopal RK, Sanniyasi E. Investigating the anti-inflammatory and anti-arthritis effects of fucoidan from a brown seaweed. Current Research in Biotechnology., 2024; 7. doi: 10.1016/j.crbiot.2024.100220.
14. Rodrigues K, Nadaf S, Rarokar N, Gurav N, Jagtap P, Mali P. QBD approach for the development of hesperetin loaded colloidal nanosponges for sustained delivery: in vitro, ex-vivo, and in vivoassessment. OpenNano. 2022;7:2022.100045. doi: 10.1016/j.onano.2022.100045.
15. Yang M, Feng X, Ding J, Chang F, Chen X. Nanotherapeutics relieve rheumatoid arthritis. J Control Release., 2017; 252: 108-24. doi: 10.1016/j.jconrel.2017.02.032, PMID 28257989.
16. Luthuli S, Wu S, Cheng Y, Zheng X, Wu M, Tong H. Therapeutic effects of fucoidan: a review on recent studies. Mar. Drugs., 2019; 17(9): 487. doi: 10.3390/md17090487, PMID 31438588.

17. Jayawardena TU, Nagahawatta DP, Fernando IP, Kim YT, Kim JS, Kim WS. A review on fucoidan structure, extraction techniques, and its role as an immunomodulatory agent. Mar. Drugs., 2022; 20(12): 755. doi: 10.3390/md20120755, PMID 36547902.
18. Ahmed MM, Fatima F, Anwer MK, Ansari MJ, Das SS, Alshahrani SM. Development and characterization of ethyl cellulose nanosponges for sustained release of brigatinib for the treatment of non-small cell lung cancer. J Polym. Eng., 2020; 40(10): 823-32. doi: 10.1515/polyeng-2019-0365.
19. GS, Chandra GK, KE, Mahapatra DR, AS, ZG. Nanoparticles and bacterial interaction of host-pathogens and the detection enhancement of biomolecules by fluorescence Raman spectroscopic investigation. Eng. Sci., 2022; 20: 341-51. doi: 10.30919/es8d767.
20. Salunke A, Upmanyu N. Formulation, development and valuation of budesonide oral nano-sponges using DOE approach: in vivo evidences. Adv. Pharm. Bull., 2021; 11(2): 286-94. doi: 10.34172/apb.2021.041, PMID 33880350.
21. Debjit B., Harish G., Pragati K., Duraivel S., Recent Advances in Novel Drug Delivery System. Pharma. Innov., 2012; 1(9): 12-31.
22. Seth D., Cheldize K., Brown D., Freeman F., Global Burden of Skin Disease: Inequities and Innovations. Curr. Dermatol Rep., 2017; 6(3): 204–210.
23. Ansel HC., Allen LV., Pharmaceutical Dosage Forms and Drug Delivery System, 7th ed., Lippincott Williams and Wilken, Baltimore; 2000.
24. Aulton ME., The Science of Dosage Form Design, 2nd ed. Churchill Livingstone; 2002.
25. Shivani S., Poladi K., Nanosponges-Novel Emerging Drug Delivery System: A Review. Int. J Pharm. Sci. Res., 2015; 6(2):1000-1012.
26. Srinivas P., Sreeja K., Formulation and evaluation of voriconazole loaded nanosponges for oral and topical delivery. Int. J Drug. Dev. Res., 2013; 5(1): 55–69.
27. Kumar S., Hematheerthan N., Ratan J., Design and Characterization of Miconazole Nitrate Loaded Nanosponges Containing Vaginal Gel. Int. J of Pharma. and Ana Res., 2016; 5(3): 410-417.
28. Aldawsari M., Design and formulation of a Topical Hydrogel Intergrating Lemongrass loaded Nanosponges with an Enhanced Antifungal Effect: In Vitro /in vivo evaluation. Int J of Nanomed., 2015; 10: 893-902.
29. Lembo D., Swaminathan S., Donalisio M., Civra A., Pastero L., Aquilano D., Vavia P., Trotta F., Cavalli R., Encapsulation of Acyclovir in new carboxylated cyclodextrin-based nanosponges improves the agent's antiviral efficacy. Int. J Pharm., 2013; Feb. 25; 443(1-2): 262-272.

30. Kehserwani R., Sachan A., Arora M., Formulation and Evaluation of Solid-Lipid Nanoparticle (SLN) Based Topical gel of Etoricoxib. J of App Pharma Sci, 2016; 4(1): 124-131.
31. Patil B., Mohite SK., Formulation Design and Development of Artesunate Nanosponges. Eur. J Pharm. Med. Res., 2016; 3(5): 206-211.
32. Tanver YS., Jain AK., Formulation and Evaluation of Diclofenac Sodium Gel Using Different Gelling Agent. Asian J Pharm. Sci., 2015; 4(1): 1-6.
33. Agrawal G., Nagpal M., Kaur G., Development and Comparison of Nanosponges & Niosome Based Gel for Topical Delivery of Tazarotene. Pharma nanotechnology, 2016; 4(3): 563-570.
34. Srinivas P., Reddy J., Formulation and Evaluation of Isoniazid Loaded Nanosponges for Topical Delivery, Pharma nanotechnology, 2015; 68-73.
35. Gangadharappa HV., Chandra Prasad SV., Singh RP., Formulation, In-vitro and In- Vivo Evaluation of celecoxib nanosponges hydrogel for topical application. J Drug Deliv. Sci. Technol., 2017; 1-48.