RESEARCH PAPER

"DEVELOPMENT AND EVALUATION OF NORFLOXACIN LOADED PVA–PVP ELECTROSPUN NANOFIBERS FOR TOPICAL ANTIBACTERIAL DRUG DELIVERY"

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ABSTRACT

Skin infections and wound-associated bacterial complications remain challenging therapeutic problems due to increasing antimicrobial resistance and limitations of conventional topical antibiotic delivery systems. The present study aimed to develop and evaluate Norfloxacin-loaded Polyvinyl alcohol (PVA)–Polyvinyl pyrrolidone (PVP) electrospun nanofibers as a localized and sustained antibacterial drug delivery system. Norfloxacin-loaded nanofibers were fabricated using the electrospinning technique and evaluated for physicochemical characteristics, drug loading efficiency, morphological properties, drug release behavior, stability, and antibacterial activity. The optimized formulation (F5) demonstrated a uniform, smooth, and bead-free fibrous structure with an average fiber diameter of 172.50 ± 17.50 nm as confirmed by scanning electron microscopy. The formulation showed satisfactory physicochemical properties with high drug entrapment efficiency (88.4%) and drug content (87.32%). Fourier-transform infrared spectroscopy confirmed the compatibility between Norfloxacin and the polymeric matrix without significant chemical interaction. X-ray diffraction analysis revealed a reduction in drug crystallinity after incorporation into the PVA–PVP nanofiber matrix. The optimized nanofiber formulation exhibited prolonged drug release up to 12 h with 74.54% cumulative drug diffusion. Furthermore, the developed nanofibers exhibited promising antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*. The findings suggest that Norfloxacin-loaded PVA–PVP electrospun nanofibers could serve as an effective topical antibacterial delivery platform for improved wound infection management.

Keywords: Electrospinning; Norfloxacin; PVA; PVP; Nanofiber; Controlled drug delivery; Antibacterial activity; Wound healing

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INTRODUCTION

Skin infections and wound-associated microbial complications remain significant healthcare challenges due to the increasing prevalence of antibiotic-resistant microorganisms and the limitations of conventional antimicrobial therapy.[1,2] Effective management of infected wounds requires maintaining an adequate concentration of antimicrobial agents at the site of infection for a prolonged period.[3] However, conventional topical dosage forms such as creams, ointments, and gels often exhibit poor site retention, rapid drug loss, and frequent application requirements, which may reduce therapeutic efficiency.[4,5]

Recent advances in nanotechnology have provided novel approaches for localized drug delivery and wound management.[6] Among various nanocarrier systems, electrospun nanofibers have gained considerable attention due to their high surface-area-to-volume ratio, interconnected porous structure, flexibility, and extracellular matrix-like morphology.[7,8] These structural properties facilitate efficient drug incorporation, controlled release, enhanced wound coverage, and improved tissue regeneration.[9]

Norfloxacin, a fluoroquinolone antibiotic, possesses broad-spectrum antibacterial activity against several Gram-positive and Gram-negative microorganisms by inhibiting bacterial DNA gyrase and topoisomerase IV enzymes.[10,11] Despite its antibacterial potential, conventional delivery of Norfloxacin may be limited by insufficient localization at the infected site and short duration of therapeutic action.[12] Incorporation of Norfloxacin into electrospun polymeric nanofibers can enhance local retention and provide sustained antimicrobial activity by maintaining effective drug concentration at the wound surface.[13]

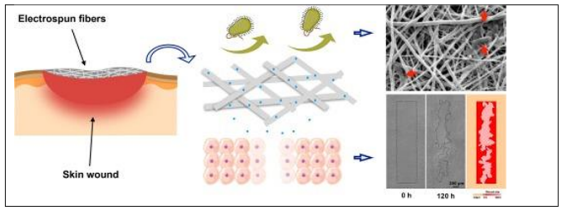


Fig No. 1: Role of Nanofibers in Wound Healing

Polyvinyl alcohol (PVA) and Polyvinyl pyrrolidone (PVP) are widely investigated biocompatible polymers for electrospinning applications because of their excellent fiber-forming ability, hydrophilicity, flexibility, and compatibility with

pharmaceutical molecules.[14],[15] The combination of PVA and PVP provides a suitable polymeric matrix for developing stable nanofibrous systems with improved drug loading, mechanical properties, and controlled release behaviour.[16]

Although several antibiotic-loaded nanofiber systems have been reported for wound healing applications, limited studies have investigated Norfloxacin-loaded PVA–PVP electrospun nanofibers with combined evaluation of physicochemical properties, sustained drug release, and antibacterial performance. Therefore, the present study aimed to develop and evaluate Norfloxacin-loaded PVA–PVP electrospun nanofibers as a localized topical antibacterial delivery system for improved infection control and wound management.

Objective of the study

1. To prepare norfloxacin containing electrospun nanofibers by using polyvinyl alcohol (PVA) and polyvinyl pyrrolidone (PVP) polymers.
2. To optimize the formulation variables for the preparation of uniform and stable nanofibers.
3. Physicochemical evaluation of prepared nanofibers for percentage yield, drug content, entrapment efficiency, folding endurance, moisture content and pH.
4. To characterize the optimized formulation by FTIR, XRD and SEM studies.
5. To study the in vitro drug release pattern of norfloxacin from the formulated nanofiber system.
6. Antibacterial Activity of Optimized Formulation against Staphylococcus aureus and Escherichia coli.
7. To test the stability of the optimized nanofiber formulation

MATERIALS AND METHODS

Materials

Norfloxacin was selected as the model antibacterial drug for the preparation of electrospun nanofibers.[17] Polyvinyl alcohol (PVA) and Polyvinyl pyrrolidone (PVP) were used as biodegradable and biocompatible polymeric carriers.[18] All other chemicals and reagents used during the formulation and evaluation studies were of analytical grade.[18]

Preparation of Norfloxacin-Loaded PVA–PVP Nanofibers

Norfloxacin-loaded polymeric nanofibers were prepared using the electrospinning technique.[19] Required quantities of PVA and PVP were dissolved separately in a suitable solvent system to obtain a clear polymeric solution.[19] Norfloxacin was added to the polymer solution and mixed thoroughly to obtain a uniform drug–polymer dispersion.[20]

The prepared solution was transferred into a syringe fitted with a metallic needle. Electrospinning was performed by applying a high voltage between the needle tip and collector surface.[19] The polymer jet formed under electrostatic force underwent solvent evaporation during flight and was deposited as a continuous nanofibrous mat. Process parameters were optimized to obtain uniform, bead-free nanofibers.[21]

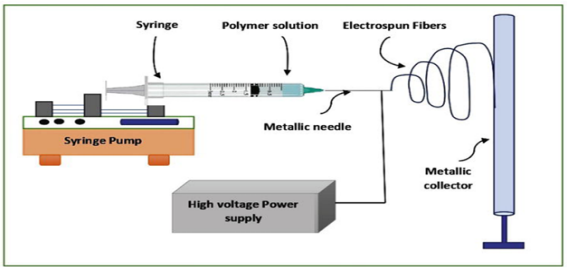


Fig No. 2: S electrospinning setup

Optimization of Nanofiber Formulation

The formulation variables including polymer concentration and electrospinning parameters were optimized to achieve desirable nanofiber characteristics.[22] The prepared formulations were evaluated for fiber morphology, drug loading efficiency, and drug release behavior to identify the optimized formulation.[22]

Evaluation of Prepared Nanofibers

The developed nanofibers were evaluated for various physicochemical and functional characteristics.

Morphological evaluation:

Surface morphology and fiber structure were examined using scanning electron microscopy (SEM).[23] Fiber diameter and uniformity were analyzed to confirm the formation of nanosized fibers.[23]

Percentage yield:

To calculate percentage yield of formulated batch, theoretical yield and practical yield was calculated. Theoretical yield is sum of polymer and drug weight. To calculate practical yield, weight of formulated nanofiber calculated using weighing balance. Obtained value was placed in percentage yield formula.

Percentage yield = practical yield /therotical yield x 100

Entrapment Efficiency

A dried 2 x 2cm nanofiber sample was added to the phosphate buffer (pH 6.8) solution. The solution was left to rest at room temperature for 7 hrs. to ensure complete nanofiber dissolution. After filtration, the amount of material loaded in

nanofiber film was measured using UV spectrometry at 278 nm.

Entrapment efficiency = actual entrapped drug amount /theoretical entrapped drug amount x 100

Drug Content

A dried 2 x 2 film dissolve in phosphate buffer solution (pH 6.8) sonicate until the drug is completely extracted.dilute the solution 1 m in 10 ml volumetic flask which

Containing 9ml pbs. After dilution nanofiber film was measured using UV spectrometry at 278 nm.

Drug content =Actual drug content in film/ Therotical drug content X100

Physicochemical compatibility studies: Fourier transform infrared spectroscopy (FTIR) was performed to investigate possible interactions between drug and polymers.[24]

Mechanical properties: The prepared nanofiber mats were evaluated for thickness, tensile strength, and flexibility to determine their suitability for topical application.[25]

In-vitro drug release study:

The in vitro drug release profile of norfloxacin-loaded nanofibers was evaluated using a modified Franz diffusion cell. A cellophane membrane, previously hydrated in phosphate buffer (pH 7.4) for 24 h, was mounted between the donor and receptor compartments. An accurately weighed nanofiber sample was placed on the donor side of the membrane. The receptor compartment contained 100 mL of phosphate buffer (pH 7.4), maintained at 37 ± 0.5°C and stirred continuously at 100 rpm using a magnetic stirrer.

At predetermined time intervals, 1 mL samples were withdrawn from the receptor medium and replaced with an equal volume of fresh buffer to maintain sink conditions. The collected samples were analyzed using a UV–Visible spectrophotometer at 278 nm. The cumulative percentage drug release was calculated and plotted against time.

Antibacterial study The inoculum of the microorganism was prepared from the bacterial cultures. 15ml of nutrient agar (Hi media) medium was poured in clean sterilized Petri plates and allowed to cool and solidify. 100 µl of broth of bacterial strain was pipette out and spread over the medium evenly with a spreading rod till it dried properly. Wells of 6mm in diameter were bored using a sterile cork borer. Solutions of the compounds (100µl/ml) were prepared in DMSO and 100µl of prepared test solutions (1mg/ml) and standard was added to the wells. The petri plates incubated at 370C for 24 h. Streptomycin (1mg/ml) was prepared as a positive control and DMSO was taken as negative control. Antibacterial activity was evaluated by measuring the diameters of the zone of inhibitions (ZI) all the determination were performed in triplicates

Formulation of nanofibers film

Table No.01: Formulation of nanofibers film

Batch code	F1	F2	F3	F4	F5	F6
Drug	0.25 %w/v	0.25 %w/v	0.25 %w/v	0.25 %w/v	0.25 %w/v	0.25 %w/v
Concentration in mg	25 mg	25 mg	25 mg	25 mg	25 mg	25 mg
Polymer PVA	8% w/v	10% w/v	12% w/v	12% w/v	12% w/v	12% w/v
Concentration in mg	0.8 g	1.0 g	1.2 g	1.2 g	1.2 g	1.2 g
PVP Concentration	—	—	—	0.5 % w/v	1% w/v	2% w/v
PVP Concentration mg	—	—	—	0.05 g	0.1 g	0.2 g
Solvent System	10ML	10ML	10ML	10ML	10ML	10ML
Drum Speed	450-650	450-650	450-650	450-650	450-650	450-650
Pump Flow Rate	0.3µL/sec	0.3µL/sec	0.3µL/sec	0.3µL/sec	0.3µL/sec	0.3µL/sec
Pump Diameter	8.9 mm	8.9 mm	8.9 mm	8.9 mm	8.9 mm	8.9 mm
Syring	2.5	2.5	2.5	2.5	2.5	2.5

e Volume	mL	mL	mL	mL	mL	mL

RESULT AND OBSERVATION

Preformulation study

Organoleptic properties drug

Table No.2 Organoleptic properties of drug

Sr. No.	Parameter	Inference
1	Nature	Crystalline
2	Colour	White in light yellow
3	Odour	Odourless
4	Taste	Bitter taste

Solubility

Norfloxacin exhibited maximum solubility in glacial acetic acid and limited solubility in water and ethanol. Therefore, glacial acetic acid was selected as co-solvent for formulation development.

Table No. 3: Solubility of drug

Sr.No	Solvent	Result
1	water	Slightly soluble
2	methanol	Sparingly soluble
3	ethanol	Sparingly soluble
4	Glacial acetic acid	Soluble

Melting point

Sr.no.	Functional group	Standard IR range (cm^{-1})	Observed (cm^{-1})
1	Carboxylic acid (C=Ostretching)	1700–1720	1712.36
2	Pyridone carbonyl (C=O stretching)	1600–1650	1614.74
3	Aromatic C=C stretching	1450–1550	1481.95
4	C–N stretching	1200–1350	1251.49
5	C–F stretching	1000–1100	1022.81

The melting point of Norfloxacin was found to be approximately 223°C by the capillary method, which corresponds to the reported literature value and indicates the purity of the drug sample

FT-IR study of drug

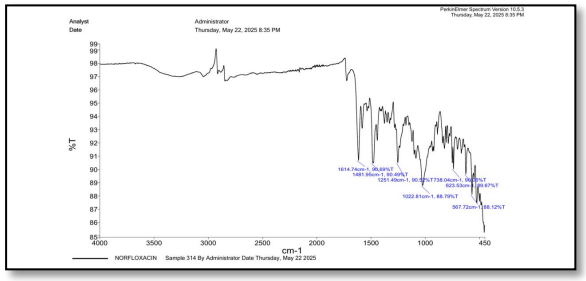


Fig No.3 FT-IR spectra of norfloxacin

Table No. 4 Interpretation of Pure Drug

FT-IR study of polymer

FTIR analysis was performed to characterize the polymer by identifying its specific functional group peaks

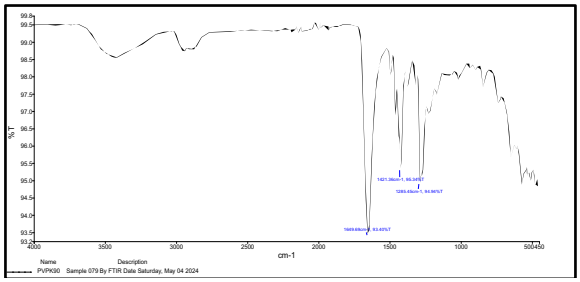


Fig No. 4 FT-IR spectra of PVP-K90

Table No.5 interpretation of PVP-K90

Sr. No	Functional group	Standard IR range (cm^{-1})	Observed (cm^{-1})
1	C=O stretching	1640-1690	1648.18
2	CH2 bending	1400-1450	1421.20
3	C-N stretching	1250-1300	1286.38
4	C-H bending	2850-2960	2950
5	O-H stretching	3200-3600	3300

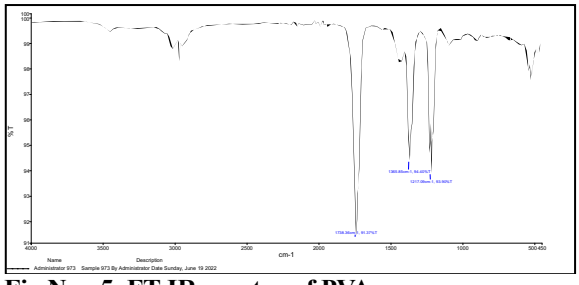


Fig No. .5 FT-IR spectra of PVA

Table No.6 interpretation of PVA

Sr. No	Functional group	Standard IR range (cm^{-1})	Observed (cm^{-1})
1	C=O stretching	1700–1750	1738.36
2	CH_2 bending / C–H bending	1350–1450	1365.85
3	C–O stretching	1080–1250	1217.09

Drug and excipient compatibility study

Table No.7 Physical observation

Sample	Color	Odor	Appearance	Observation
Pure Norfloxacin	Pale yellow	Odorless	Crystalline powder	No change
PVA	White	Odorless	Fine powder	No change
PVP	White	Odorless	Fine hygroscopic powder	No change
Drug + PVA	Off-white	Odorless	Uniform mixture	No incompatibility observed
Drug + PVP	Off-white	Odorless	Uniform mixture	No incompatibility observed
Drug + PVA + PVP	Off-white	Odorless	Homogeneous mixture	No visible interaction observed

FT-IR study of drug and excipient

FTIR analysis was performed to identify functional groups and confirm drug-excipient compatibility through characteristic peak observation

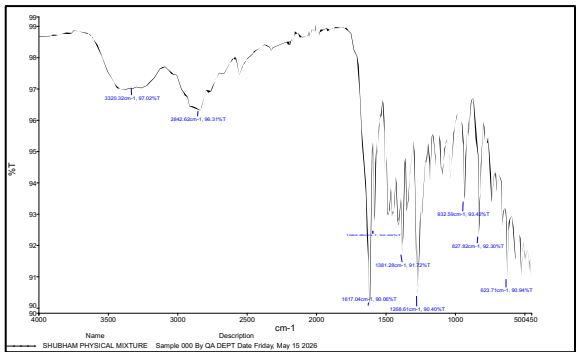


Fig No. 6 FT-IR spectra of drug & excipient

Table No .8 Interpretation of mixture of drug and polymer

Sr.no	Functional group	Standard IR Range (cm^{-1})	Observed (cm^{-1})
1	C–H stretching	2800–3000	2842.62
2	C=O stretching	1600–1700	1617.04
3	C=C stretching	1500–1600	1582.86
4	C–N stretching / O–H bending	1300–1450	1381.28
5	C–O stretching	1200–1300	1268.61
6	C–F stretching	900–1000	932.59
7	C–H bending	800–850	827.82

Calibration curve

The observation value of the drug at different concentration was obtained by using UV spectrometry .the slope of equation y=0.057x+0.003 with $R^2 = 0.999$ was obtained by plotting absorbance vs concentration graph .the graph of concentration vs absorbance is plotted below

Table No.9 absorbance value of norfloxacin on UV

Sr. No.	Conc (µg/mL)	Absorbance (nm)
1	5	0.286
2	10	0.579
3	15	0.861
4	20	1.148
5	25	1.431

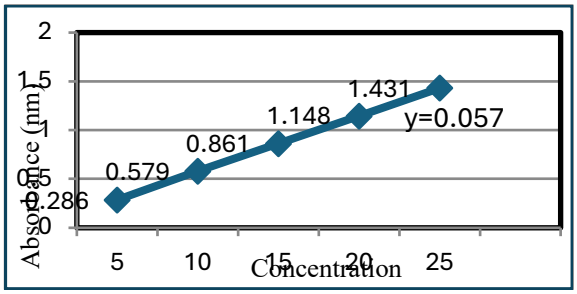


Fig No. 7 .calibration curve of norfloxacin

Evaluation of nanofiber

Physical appearance

Drug loaded nanofiber film using combination of PVA and PVP –K90 showed white to off white ,smooth ,consistent ,rectangular in shape

Fig No. 8 formulation of nanofiber film using PVA and PVP-K90Percentage yield

Table No. 10 Percentage yield

Batch NO.	Theoretical (mg)	Practical (mg)	Percentage (%)
1	412	280	68%

2	512	380	75%
3	600	500	83%
4	640	540	84%
5	**670**	**580**	**87%**
6	700	590	86%

Fig No. 9 Percentage yield

The percentage yield of norfloxacin-loaded nanofiber formulations (F1–F6) ranged from 68% to 87%. Among all batches, F5 showed the highest yield (87%), while F1 showed the lowest yield (68%). The increase in percentage yield from F1 to F5 indicates improved fiber formation and reduced material loss during electrospinning. The results suggest that polymer concentration and processing conditions influenced the production yield of the nanofibers.

PH test

Table No. 11 PH test observation

Sr. no	Batch code	PH
1	F1	6.3
2	F2	6.5
3	F3	6.6
4	F4	6.6
5	**F5**	**6.8**
6	F5	6.9

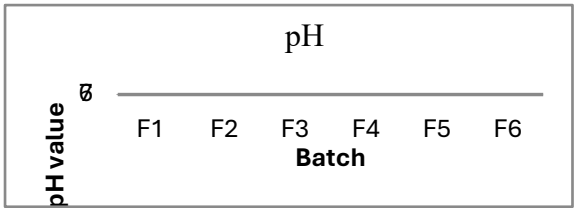


Fig No. 10 PH test observation

Folding Endurance

Table No.12 Folding endurance and % moisture content

Sr .No	Batch code	Folding endurance	%Moisture content
1	F1	64	4.6%
2	F2	77	4.1%
3	F3	82	5.7%
4	F4	97	6.1%
5	F5	114	6.6%
6	F6	105	7.5%

The folding endurance of the prepared nanofiber formulations ranged from 64 to 114 folds, while the moisture content ranged from 4.1% to 7.5%. Among all batches, F5 showed the highest folding endurance (114 folds), indicating good flexibility and strength, whereas F1 showed the lowest value (64 folds). The highest moisture content was observed in F6 (7.5%), while F2 showed the lowest moisture content (4.1%). The results indicate that the formulations possessed satisfactory mechanical properties and moisture retention capacity.

FT-IR of nanofiber film

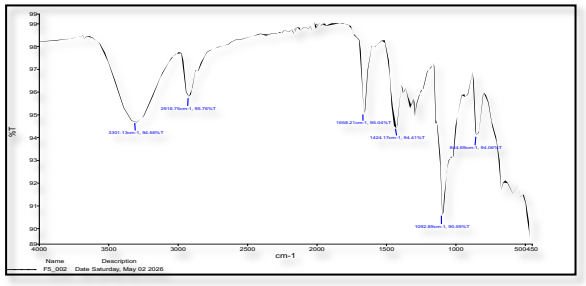


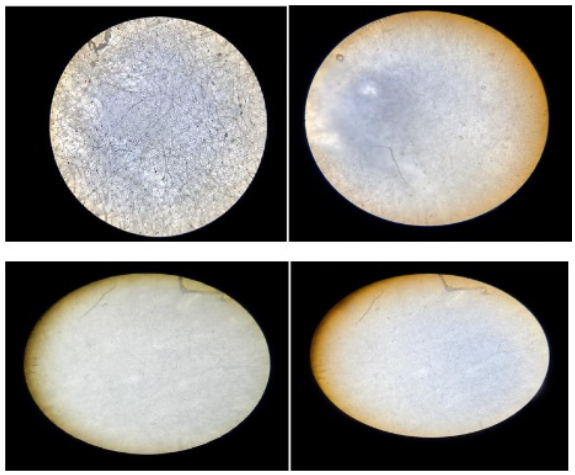
Fig No .11 FT-IR spectra of drug loaded nanofiber

Table No.13 Interpretation of drug loaded nanofiber

Sr No.	Functional group	Standard IR range (cm^{-1})	Observed (cm^{-1})
1	O–H stretching	3200–3500	3331.35
2	C–H stretching	2850–3000	2918.75
3	C=O stretching	1600–1700	1652.21
4	C–N stretching / O–H bending	1400–1500	1428.47
5	C–O stretching	1000–1200	1102.58

Microscopic images of nanofiber film

Fig No.12 Microscopic images



Optical microscopy confirmed the successful formation of a uniform and interconnected nanofibrous structure, indicating efficient

electrospinning and suitability of the formulation for topical drug delivery.

SEM

Scanning Electron Microscopy was performed to evaluate the surface morphology and fiber architecture of the optimized Norfloxacin-loaded PVA–PVP electrospun nanofibers. The SEM micrographs at different magnifications revealed the successful formation of a three-dimensional fibrous network consisting of continuous and randomly oriented nanofibers.The nanofibers exhibited a smooth surface with no evidence of major bead formation, indicating proper optimization of electrospinning parameters. The fibers were found to be interconnected, forming a porous structure favorable for drug loading and diffusion. Measurement of fiber diameter from SEM images showed nanofiber diameters ranging from approximately **149.58 nm to 192.36 nm**, with an average fiber diameter of approximately **172.50 ± 17.50 nm**.No visible drug crystals were observed on the fiber surface, suggesting uniform distribution and successful encapsulation of Norfloxacin within the polymeric matrix. The porous fibrous architecture obtained is expected to provide a large surface area, facilitating efficient drug release and enhanced antibacterial activity.

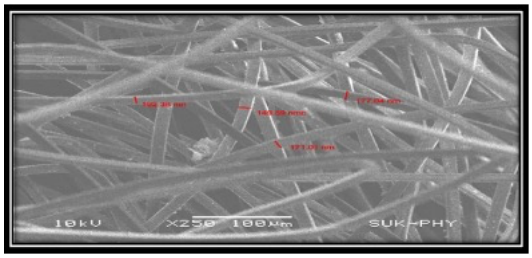


Fig No. 13 SEM Images of Nanofibre

Entrapment efficiency

Table No. 14 entrapment efficiency

Sr .no	BATCH	%Entrapment efficiency
1	F1	77.8 %
2	F2	79.4%
3	F3	81.5%
4	F4	83.2%
5	**F5**	**88.4%**
6	F6	86.1%

The entrapment efficiency of norfloxacin-loaded nanofiber formulations (F1–F6) ranged from 77.8% to 88.4%. Among all formulations, F5 exhibited the highest entrapment efficiency (88.4%), whereas F1 showed the lowest value (77.8%). The gradual increase in entrapment efficiency from F1 to F5 indicates improved drug incorporation within the polymeric matrix. The results demonstrate that the formulation variables significantly influenced the drug entrapment capacity of the nanofibers.

Drug content

Table No 15 Drug Content

Sr .no .	**Batch**	**% Drug content**
1	F1	78.70%
2	F2	80.54%
3	F3	82.64%
4	F4	84.34%
5	**F5**	**87.32%**
6	F6	87.00%

The drug content of norfloxacin-loaded nanofiber formulations (F1–F6) ranged from 78.70% to 87.32%. Among all formulations, F5 showed the highest drug content (87.32%), while F1 exhibited the lowest value (78.70%). The increase in drug content from F1 to F5 indicates uniform drug distribution and effective incorporation of norfloxacin within the nanofiber matrix. The results suggest that formulation composition influenced the drug loading capacity of the prepared nanofibers.

XRD

The XRD diffractogram of pure norfloxacin exhibited characteristic sharp peaks at 2θ values of approximately 14.8°, 19.2°, 25.6°, and 28.4°, confirming its crystalline nature. In the optimized nanofiber formulation (F5), these characteristic peaks were markedly reduced in intensity and appeared broadened. The decrease in peak intensity indicates a reduction in drug crystallinity due to its incorporation within the PVA/PVP polymer matrix. The absence of any additional peaks further suggests that no chemical interaction occurred between the drug and polymers. These findings confirm the successful entrapment of norfloxacin in the nanofibers and its conversion into a partially amorphous state, which may contribute to improved drug release.

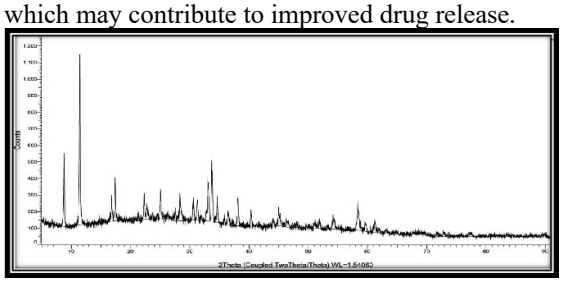


Fig .No. 14 XRD of Norfloxacin

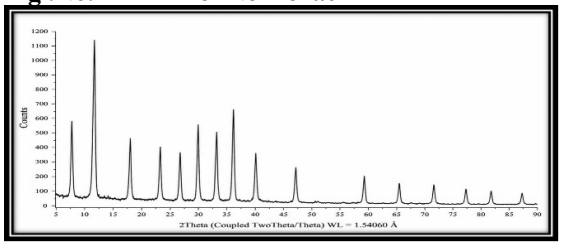


Fig No.15 XRD of drug loaded nanofiber

In–vitro drug release:

Table No. 16 In-vitro Drug release Study

Time (hr)	F1	F2	F3	F4	F5	F6
0	0%	0%	0%	0%	0%	0%
1	12.54%	11.43%	10.32%	15.43%	17.1%	16.65%
2	20.54%	22.54%	19.54%	24.32%	28.54%	26.54%
3	26.89%	27.54%	25.54%	31.45%	33.48%	30.45%
4	30.54%	31.56%	29.65%	34.85%	37%	35.34%
5	33.43%	35.32%	32%	41.34%	43.54%	39.43%
6	37.54%	39.94%	35.89%	47.43%	51.47%	46%
7	42.34%	44.65%	40.67%	52.34%	57.87%	52.54%
8	47.54%	48.87%	45.54%	57.54%	61.54%	57.21%
9	51.32%	52%	49.21%	60%	63.76%	61.54%
10	53.6%	54.45%	55.54%	65.67%	68%	64.57%
11	55.12%	58.54%	59.65%	67.54%	70.34%	68.64%
12	57.48%	60.53%	65.87%	69.85%	**74.54%**	71.24%

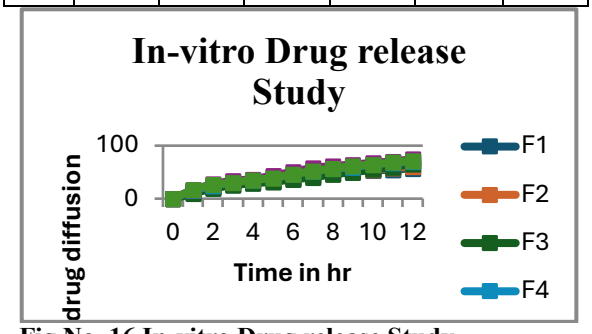


Fig No. 16 In-vitro Drug release Study

In Vitro Drug Release Study

The in vitro drug release study of norfloxacin-loaded nanofiber formulations (F1–F6) was carried out for 12 h. All formulations showed a gradual increase in drug release over time. At the end of 12 h, the cumulative drug release ranged from 57.48% to 74.54%. Among all formulations, F5 exhibited the highest drug release (74.54%), followed by F6 (71.24%) and F4 (69.85%), whereas F1 showed the lowest release (57.48%). The results indicate that formulation F5 provided the most efficient and sustained release profile and was selected as the optimized formulation.

Stability Study

Table No. 17 observation at room temperature and accelerated temperature during stability study

Sr.No	Number of month	Physical appearance	PH	In vitro drug release %	
				25°C	40°C
1	Initial	Smooth, white nanofiber mat	6.8	74.54 %	74.54 %
2	1	No significant change	6.7	74.40 %	73.76 %
3	2	Slight softness observed	6.7	73.25 %	71.52 %
4	3	Stable appearance maintained	6.7	72.00 %	70.50 %

The optimized formulation was found to be physically stable with no significant change in appearance, pH and drug release profile during storage for three months. The results showed that the stability of Norfloxacin loaded PVA-PVP electrospun nanofibers was sufficient at both room temperature (25°C) and accelerated temperature (40°C) conditions.

Antibacterial study

The antibacterial profile of **F5** was evaluated by measuring the zone of inhibition against *S.aureus*(ATCC 29213), *E. coli* (ATCC 25922) bacterial strains via well diffusion method. The compound **F5** exhibited good antibacterial activity as compared to the standard streptomycin.

Table No. 18 Antibacterial Activity of Test Compound Against *S. aureus*

SR.NO	SAMPLES	ZONE IN DIAMETER (mm)
1	Control	00
2	Standard (Streptomycin)	26

3	F5	24

Table No. 17 Antibacterial Activity of Test Compound Against *E. Coli*

SR.NO	SAMPLES	ZONE IN DIAMETER (mm)
1	Control	00
2	Standard (Streptomycin)	27
3	F5	23

CONCLUSION

Norfloxacin-loaded PVA/PVP nanofibers were successfully prepared by electrospinning technique and evaluated for their physicochemical and antibacterial properties. Among the developed formulations, F5 showed the highest percentage yield, drug content, entrapment efficiency, folding endurance and cumulative drug release. SEM analysis confirmed the formation of uniform nanofibers while FTIR, DSC and XRD studies revealed the successful incorporation of norfloxacin within the polymer matrix. The optimized formulation exhibited sustained drug release and effective antibacterial activity against Staphylococcus aureus and Escherichia coli. The present investigation revealed that the developed nanofiber system is a promising carrier for the topical delivery of norfloxacin in wound management.

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REFERENCES

1. Bhardwaj N, Kundu SC. Electrospinning: a fascinating fiber fabrication technique. Biotechnol Adv. 2010;28(3):325-347.
2. Xue J, Wu T, Dai Y, Xia Y. Electrospinning and electrospun nanofibers: methods, materials, and applications. Chem Rev. 2019;119(8):5298-5415.
3. Sill TJ, von Recum HA. Electrospinning: applications in drug delivery and tissue engineering. Biomaterials. 2008;29(13):1989-2006.
4. Greiner A, Wendorff JH. Electrospinning: a fascinating method for the preparation of ultrathin fibers. Angew Chem Int Ed. 2007;46(30):5670-5703.
5. Boateng JS, Matthews KH, Stevens HNE, Eccleston GM. Wound healing dressings and drug delivery systems. J Pharm Sci. 2008;97(8):2892-2923.
6. Li D, Xia Y. Electrospinning of nanofibers: reinventing the wheel? Adv Mater. 2004;16(14):1151-1170.
7. Agarwal S, Wendorff JH, Greiner A. Use of electrospinning technique for biomedical applications. Polymer. 2008;49(26):5603-5621.
8. Al-Abduljabbar A, Farooq I. Electrospun polymer nanofibers: processing, properties and applications. Polymers. 2023;15:65.
9. Nadaf A, Gupta A, Hasan N, et al. Recent update on electrospinning and electrospun nanofibers: current trends and applications. RSC Adv. 2022;12:23808-23828.
10. Chen K, Li Y, Li Y, et al. Stimuli-responsive electrospun nanofibers for drug delivery and wound dressing. J Nanobiotechnol. 2023;21:237.
11. Haider A, Haider S, Kang IK. A comprehensive review summarizing electrospinning process and applications. Arab J Chem. 2018;11:1165-1188.
12. Pillay V, Dott C, Choonara YE, et al. A review of electrospun nanofibers for drug delivery applications. J Nanomater. 2013;2013:789289.
13. Pant B, Park M, Park SJ. Drug delivery applications of core-sheath nanofibers prepared by coaxial electrospinning. Pharmaceutics. 2019;11:305.
14. Homaeigohar S, Boccaccini AR. Antibacterial biohybrid nanofibers for wound dressings. Acta Biomater. 2020;107:25-49.
15. Zamani M, Morshed M, Varshosaz J, Jannesari M. Controlled release of drugs from electrospun nanofibers. Iran Polym J. 2010;19:499-521.
16. Ailincai D, et al. Mesoporous chitosan nanofibers loaded with norfloxacin and coated with phenylboronic acid perform as bioabsorbable active dressings to accelerate the healing of burn wounds. Carbohydr Polym. 2023;318:121135.
17. Palani N, Vijayakumar P, Monisha P, et al. Electrospun nanofibers synthesized from polymers incorporated with bioactive compounds for wound healing. J Nanobiotechnol. 2024;22:211.
18. Yan S, Qian Y, Haghayegh M, et al. Electrospun organic/inorganic hybrid nanofibers for accelerating wound healing. J Mater Chem B. 2024;12:3171-3190.

19. Yang J, Xu L. Electrospun nanofiber membranes with various structures for wound dressing. Materials. 2023;16:6021.
20. Zheng Q, Xi Y, Weng Y. Functional electrospun nanofibers: fabrication, properties and wound-healing applications. RSC Adv. 2024;14:3359-3378.
21. Lu X, Zhou L, Song W. Recent progress of electrospun nanofiber dressing in promotion of wound healing. Polymers. 2024;16:2596.
22. Wang B, Lu G, Song K, et al. PLGA-based electrospun nanofibers loaded with dual bioactive agents as potential wound dressing materials. Colloids Surf B Biointerfaces. 2023;231:113570.
23. Yu DG, Li JJ, Williams GR, Zhao M. Advanced electrospun nanofiber drug delivery systems and pharmaceutical applications. J Drug Deliv Sci Technol. 2024;92:105342.
24. Islam R, Islam KS, Chowdhury N, et al. Electrospun nanofibers: process, merits, challenges and usefulness. J Ind Text. 2025.
25. Ramakrishna S, Fujihara K, Teo WE, Lim TC, Ma Z. An Introduction to Electrospinning and Nanofibers. Singapore: World Scientific Publishing; 2005.
26. Kenawy ER, Bowlin GL, Mansfield K, et al. Release of tetracycline hydrochloride from electrospun polymeric nanofibers. J Control Release. 2002;81(1-2):57-64.