



METFORMIN HCL LIPOSOMAL DRUG DELIVERY SYSTEM: FORMULATION AND IN-VITRO EVALUATION

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ABSTRACT

The medicine launch from Liposomes depends upon many aspects consisting of the structure of Liposomes, the kind of medicine encapsulated and nature of the cell. Once it is released a medicine that generally goes across the membrane of a cell will certainly enter the cell, various other medicines will not go into. Metformin HCl is a short biological half-life. This research study targeted at Formula As well as In-Vitro Assessment of Liposomal Drug Shipment System of Metformin HCl in order to boost its bioavailability. In examination study the result of the differing make-up of lipids on the residential or commercial properties such as encapsulation efficiency, fragment size as well as medication release were researched. Stage change research was executed to validate the total interaction of Metformin HCl with bilayer structure of liposome. Moreover, the launch of the drug was likewise modified as well as crossed a duration of 8 h in all solutions. F1 became one of the most acceptable formula in so far as its residential or commercial properties were concerned. Additionally, release of the medicine from the most sufficient formula (F1) was assessed via dialysis membrane layer to get the idea of medication launch.

KEYWORDS: Liposomes, Metformin HCl, Bioavailability.

INTRODUCTION

The most recent development in vesicle design for transcutaneous bioactive delivery is the use of elastic liposomes, which differ from conventional liposomes due to their characteristic fluid membrane with high elasticity.^[1] Elastic liposomes have been defined as specially designed vesicular particles, consisting of at least one inner aqueous compartment surrounded by a lipid bilayer with appropriately tailored properties. Elastic liposomes consist of phospholipids, surfactants such as edge activators, and an inner aqueous compartment enclosed within a lipid bilayer capable of encapsulating hydrophilic (in an aqueous chamber) and lipophilic (in a lipid bilayer) molecules.^[2]

Drug delivery systems using vesicular carriers have soft, flexible, self-regulating, and self-optimizing vesicular characteristics. Greater flexibility of elastic liposomal membranes is achieved by mixing suitable surface-active components in the proper ratios.^[3] These properties allow them to penetrate more easily into deeper layers of the skin and circulation. In Elastic liposomes, elasticity is stress controlled, owing to the composition dependence of the membrane bending energy.^[4] They are elastic, very deformable vesicles which consist of phosphatidylcholine in combination with an edge-active surfactant like sodium cholate and span 80. Elastic

liposomes are applied non-occluded to the skin and are reported to permeate through the stratum corneum lipid lamellar regions as a result of the hydration or osmotic force in the skin.^[5] Elastic liposomes passage through the normally confining pores is then governed by the basic principles of elasto mechanics. However, elastic liposomes resemble lipid vesicles, liposomes, in morphology but functionally; elastic liposomes are sufficiently deformable to penetrate pores much smaller than their own size. They are metastable, which makes the vesicle membrane ultra flexible and thus the vesicles are highly deformable.^[6] Metformin is a biguanide antihyperglycemic agent and first-line pharmacotherapy used in the management of type II diabetes. Metformin is considered an antihyperglycemic drug because it lowers blood glucose concentrations in type II diabetes without causing hypoglycemia. It is commonly described as an "insulin sensitizer", leading to a decrease in insulin resistance and a clinically significant reduction of plasma fasting insulin levels. Another well-known benefit of this drug is modest weight loss, making it an effective choice for obese patients type II diabetes.^[7-9]

The aim of the present study is To Formulation and In-vitro evaluation of liposomal drug delivery system of Metformin HCl.

MATERIALS

Metformin HCl Purchased from Aurobindo Laboratories Ltd. Cholesterol, Chloroform from S.D.Fine chemicals Pvt.Ltd, Mumbai. Soybean lecithin, Tween 80 from Merck specialities Pvt.Ltd., Mumbai.

METHODOLOGY

Preformulation study

Standard calibration curve

Criterion calibration curve of Metformin HCl was developed using phosphate buffer pH 7.4 and approximated by UV-Visible spectrophotometer at 243nm.

General treatment for the prep work of calibration contour by uv

A gracefully cure of (1mg/ml) of basic medication was readied, later called for weakenings were made with a phosphate obstruction pH 7.4. To an assortment of 10ml volumetric carafes aliquots normal choices were taken and the amount was utilized a phosphate boundary pH 7.4. The absorbance of these arrangements was estimated at specific wave size of ideal absorbance, utilizing 1cm quartz cuvette in UV-Noticeable spectrophotometer. Absorbance esteems were plotted as opposed to comparing fixation to get regular alignment bend.

Medication excipient similarity explores

Infrared (IR) spectroscopy was performed utilizing a FTIR Spectrophotometer (Bruker) and furthermore the range was recorded in the frequency district of 4000 to 400 cm^{-1} . The strategy contained scattering a model (drug alone or mix of medicine just as excipients) in KBr and squeezing into circles by applying a worry of 5 parcels for 5 minutes in a water driven press. The pellet was put in the light course and furthermore the range was obtained.

Methodology For The Preparation Of Metformin HCl Liposome

The planning of liposomes with Soybean lecithin was set up by dried out meager film hydration strategy utilizing a revolving evaporator (Aditya logical). Soyalecithin, cholesterol tween 80 and were disintegrated in 10 mL chloroform in 250mL round base (RB) jar. The chloroform was disintegrated under vacuum using turning streak evaporator, which empowers soya lecithin to frame a dainty totally dry film on the dividers of the carafe. This framework was kept up at vacuum and 40 ° C for an additional 10min, after complete end of natural dissolvable as appeared by visual perceptions. Rankles were set up by hydrating the lipid film within the sight of 10mL phosphate support pH 7.4. Liposomes made were sonicated for 30 minutes. to limit the size of the vesicles.

In-process Checks throughout formulation of Metformin HCl liposomes

RPM

65-70rpm (Film formation),
50-55rpm (Hydration),

Temperature level

40-45 ° C (Film formation),

65-70 ° C (Hydration),

The composition and also ratios of lecithin, cholesterol and Tween 80 for various sorts of Liposomes were discussed in Table No. 10.

Characterization of liposomes

- Medicine entrapment efficiency.
- Particle size analysis.
- Zeta potential evaluation.

Medicine entrapment performance or drug content

Capture productivity of Liposomes was built up by centrifugation method. Aliquots. (1 ml) of liposomal dissemination experienced centrifugation on a research center rotator (REMI CM-12 AND ALSO) at 3500 rpm for a span of an hour and a half. The unmistakable supernatants were expelled cautiously to various non-entangled Metformin HCl and furthermore absorbance recorded at 231 nm. The trash in the centrifugation tube was watered down to 100 ml with phosphate support pH 7.4 and furthermore the absorbance of this administration was recorded at 231 nm. Measure of Metformin HCl in supernatant and silt offered a total amount of Metformin HCl in 1 ml dispersion.

The amount of medicine packed was identified by the formula

Medicine loading = Overall quantity of medicine in solution-- amount drug present in supernatant.

% of drug web content = (amount of medication crammed/ Overall medicine) x 100.

Fragment dimension evaluation

Molecule measurement of the arrangements was seen under an examining electron magnifying lens (Hitachi), one decrease of Liposomes suspension were mounted on the wound secured with clean glass just as secured with gold just as were seen under the filtering electron magnifying lens at an accelerating voltage of 15KV and photomicrographs of suitable amplifying was gotten. The SEM of the equation given in Figure No. 20.

Zeta Prospective Analysis

Zeta probability is a physical private property which is appeared by any sort of section in suspension. It very well may be used to improve the recipes of suspensions just as arrangements. Ability of the zeta limit can limit the second expected to create test arrangement. It is furthermore an assistance in foreseeing long haul security. The size of the zeta conceivable gives a pointer of the imminent soundness of the colloidal framework. On the off chance that all the pieces in suspension have a tremendous troublesome or ideal zeta planned then they will regularly will in general annulment each other just as there will absolutely be no propensity for the sections to discover together. In any case, if the pieces have low zeta potential worths after that there will absolutely be no

strain to stop the pieces working together just as flocculating.

The importance of zeta plausibility is that its value can be identified with the security of colloidal disseminations. Along these lines, colloids with high zeta limit (negative or positive) are electrically balanced out while colloids with low zeta possibilities regularly will in general coagulate or flocculate. A value of 25mV (positive or antagonistic) can be taken as the rough worth that partitions low-charged surfaces from high-charged surfaces. The zeta potential was dissected by Malvern Zetasizer.

In vitro prescription dispatch research study

The dispatch considers were executed in 250 ml container comprising of 100 ml Phosphate obstruction. Phosphate cradle pH 7.4 (100 ml) was situated in a 250 ml receptacle. The measuring glass was set up on an attractive stirrer just as the instrument was equilibrated at $37 \pm 50C$. Dialysis layer was taken just as one finish of the film was fixed. In the wake of separating of non-ensnared Metformin HCl, liposome dissemination was finished the dialysis film layer and furthermore opposite end was closed. The dialysis film containing the example was required to be postponed in the medium. Aliquots were pulled back (5 ml) at subtleties periods, filtering framework just as the contraption was quickly reestablished with identical measure of new obstruction apparatus.

Dispatch kinetics

To assess the in vitro dispatch information diverse dynamic structures were use to clarify the dispatch energy. The zero request rate Eq. (2) characterizes the frameworks where the medication dispatch rate is free of its core interest. The principal request Eq. (3) characterizes the dispatch from framework where dispatch cost is center ward. Higuchi (1963) depicted the dispatch of drugs from insoluble framework as a square birthplace of time dependent procedure dependent on Fickian dispersion.

The results of artificial insemination release account acquired for all the solutions were plotted in modes of information therapy as adheres to

1. Absolutely no - order kinetic design-- Collective % medication launched versus time.
2. First-- order kinetic version-- Log collective percent medicine remaining versus time.
3. Higuchi's design-- Cumulative percent medication released versus square root of time.
4. Korsmeyer formula/ Peppas's model-- Log advancing percent medicine released versus log time.

Absolutely no order kinetics

Absolutely no order launch would certainly be forecasted by the following equation:.

$$A_t = A_0 - K_0t.$$

When the information is plotted as cumulative percent drug release versus time, if the story is direct then the information obeys Absolutely no-- order kinetics as well as its slope is equal to Absolutely no order release consistent K_0 .

First order kinetics

First - order release could be anticipated by the following equation:.

$$\text{Log } C = \text{log } C_0 - Kt/ 2.303.$$

When the information plotted as log collective percent medication staying versus time, generates a straight line, indicating that the release comply with first order kinetics. The constant „ K_1 “ can be gotten by multiplying 2.303 with the slope worth.

Higuchi's version

Drug release from the matrix tools by diffusion has been described by following Higuchi's classical diffusion equation.

$$Q = [DC/ \tau(2A - ECs) Cst]^{1/2}.$$

When the data is spewed according to formula i.e. cumulative medication release versus square origin of time produces a straight line, showing that the medicine was released by diffusion device. The slope amounts to „ K “ (Higuchi's 1963).

Korsmeyer Formula/ Peppas's Model

To examine the mechanism of medicine release from the liposomal service, the release information was also fitted to the popular exponential equation (Korsmeyer equation/ Peppas's law equation), which is commonly used to explain the medication launch habits from polymeric systems.

$$Mt/ M_\infty = Ktn.$$

Short-term Stability Researches

Stability studies were done to examine the leakage of the medication from the liposome throughout storage space. Liposomal suspensions of Metformin HCl of maximized formulations were secured in 20 mL glass vials and saved at refrigeration temperature ($2 - 8^\circ C$) and area temperature ($25 \pm 2^\circ C/ 60 \pm 5\% R.H$) for a period of 2 months. Samples from each liposomal formulation which are maintained for assessment were taken out at guaranteed time intervals. The taken out examples were In-vitro medicine release studies at 231 nm.

RESULTS AND DISCUSSION

Standard Calibration Curve Of Metformin HCl In UV Spectrophotometer

The UV absorbance's of Metformin HCl standard services in the variety of 10-50 $\mu\text{g}/ \text{ml}$ of medicine in buffer pH 7.4 revealed linearity at λ_{max} 243nm. The linearity was outlined for absorbance(A) against concentration (C) with R^2 value 0.999 and also with the slope equation $y = 0.019x - 0.001$. The absorbance values and also basic contour received

Table 1: Standard Reading of UV Results.

Concentration (µg/ml)	Absorbance at 231nm
0	0
10	0.199
20	0.383
30	0.603
40	0.771
50	0.994

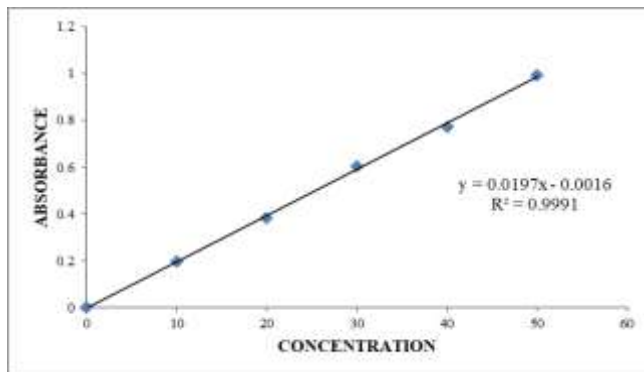


Figure: 1 Standard Graph of Metformin HCl in Phosphate Buffer of pH 7.4.

Qualitative and Quantitative Lipid Compositions of Different Formulations

Table 2 Table shows qualitative and quantitative lipid compositions of different formulations.

Ingredients	F1	F2	F3	F4	F5	F6
Drug(mg/ml)	20	20	20	20	20	20
Soya lecithin (mg)	240	270	210	180	210	180
Cholesterol(ml)	60	30	90	120	90	120
Chloroform(ml)	5	5	5	5	5	5
Tween 80(ml)	0.5	0.5	0.5
PBS 7.4(ml)	10	10	10	10	10	10
Hydration time	20	35	30	20	30	30

Drug Entrapment Efficiency of Metformin HCl

Table 3: Drug Entrapment Efficiency of Metformin HCl.

S. no.	Formulation code	Percentage entrapped drug
1	F1	79.75
2	F2	82.96
3	F3	82.62
4	F4	78.39
5	F5	78.86
6	F6	78.81

Percentage of Drug Entrapment Efficiency of Plot for F1 to F6 Formulations

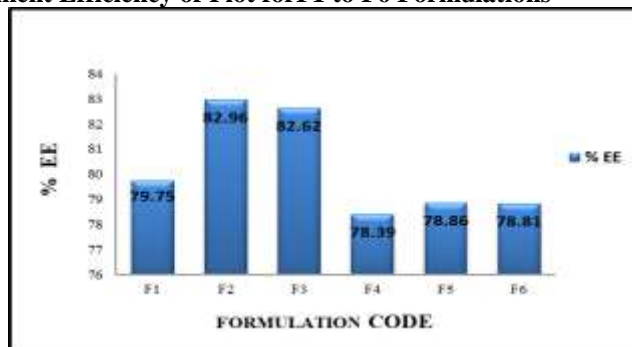


Figure: 2 Figure Shows Percentage of Drug Entrapment Efficiency of Plot for F1 to F6 Formulations.

Inference: The portion entrapment was optimal F2 is 82.96% as well as minimum for F4 is 78.39 %. The data recommends that focus with respect to the formulation

represent the essential worth as much as which the entrapment enhanced as well as past that its beginning reducing.

Particle size analysis

SEM Photography of Liposomal Solution for F2 Formulation



Figure 3: Figure Shows SEM Photography of Liposomal Solution for F2 Formulation.

Inference: The form and also morphology of the liposome bead was determined by SEM show the round shape, smooth surface and also nano dimension variety

of blister. Showing Multi lamellar vesicles structure under electron microscopic research study verifying the vesicle attributes.

Zeta Potential for Metformin HCl Liposomal Solution for F2 Formulation

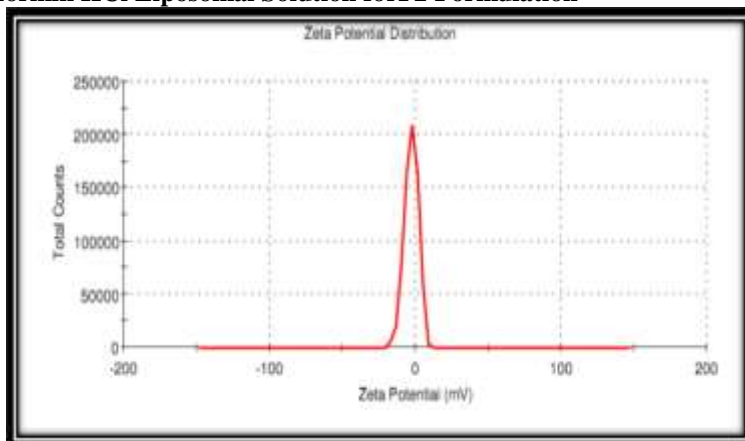


Figure 4: Figure Shows Zeta Potential for Metformin HCl Liposomal Solution for F2 Formulation.

Inference: The zeta plausibility of improved detailing (F2) which is picked dependent on capture viability. The worth was - 0.271 mV which shows that the surface

region of liposomes is overwhelmed by the anions just as indicated that readied liposome have enough charge to avoid total of vesicles.

In vitro dissolution data

In Vitro Cumulative % Drug Release Profile of Metformin HCl Liposomal Formulations

Table 4: Showing table In-vitro drug release values of the Metformin HCl.

Time(Hr)	F1	F2	F3	F4	F5	F6
0	0	0	0	0	0	0
1	8.29	5.68	10.65	12.74	13.11	15.13
2	15.36	12.21	20.21	25.31	26.05	28.06
4	33.53	28.77	39.85	40.5	42.92	45.01
6	58.21	51.65	63.56	68.9	67.53	68.62
10	78.85	74.25	81.56	83.78	84.86	85.07
12	95.85	89.46	92.59	94.84	95.25	93.67
24	100	96.31	100	100	100	99.86

In Vitro Drug Release Study of F1 to F6

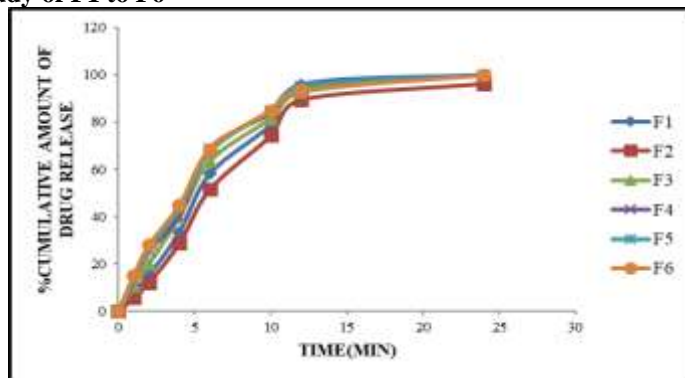


Figure 5: Showing graph of drug release studies of F1-F6.

Inference: The in vitro dissolution profile ready formulations was figured out by membrane layer diffusion technique. The dissolution was executed for a period of 24 hrs in 7.4 pH phosphate barrier.

The collective percent release of F1 to F6 formulas at various time periods was computed and tabulated in the collective percent drug launch in all formulas was plotted versus time in the Maximum percent of medicine release was discovered in F2 solution which has maximum

medicine entrapment.

Release kinetics

The release kinetics of F1, F2, F3, F4, F6 solutions were researched. All formulas follow Zero order launch kinetics and adhere to case II transport when it related to the Korsmeyer-Peppas's Model for system of medication release. F2 formulation has far better kinetic outcomes when contrasted to F1 to F6 formulas.

Zero Order Release Model of Metformin HCl Liposomal Optimized Formulation

Table 5: Table shows Zero Order Release Model of Metformin HCl Liposomes.

S. No.	Time (Hrs)	%Cumulative drug release
0	0	0
1	1	5.68
2	2	12.21
3	4	28.77
4	6	51.65
5	10	74.25
6	12	89.46
7	24	96.31

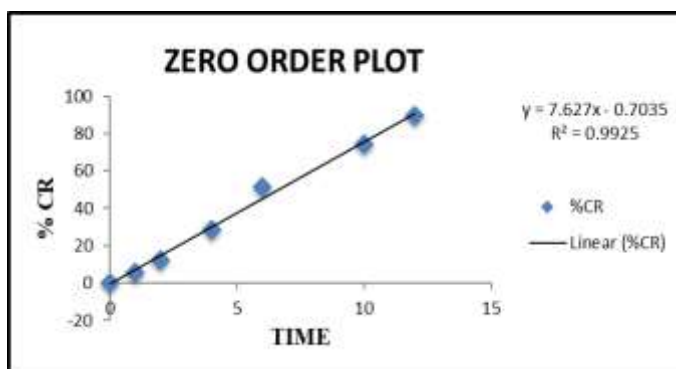


Figure 8.6: Zero order plot for optimized formulation.

First Order Release Model of Metformin HCl Liposomal Optimized Formulations

Table 6: Table Shows First Order Release Model Of Metformin HCl Liposomes.

S. No.	Time(Hrs)	Log% drug retained
0	0	2
1	1	1.974604
2	2	1.943445

3	4	1.852663
4	6	1.684396
5	10	1.410777
6	12	1.022841
7	24	0.567026

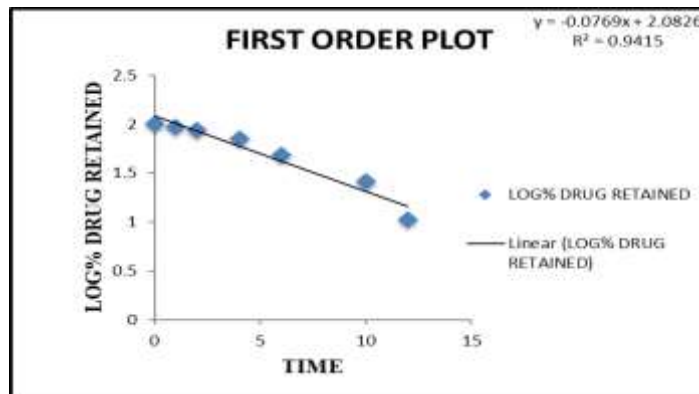


Figure 8.7: First order plot for optimised formulation.

Higuchi Release Model of Metformin HCl Liposomal Optimized Formulations

Table 7: Table Shows Higuchi Release Model Of Metformin HCl Liposomes.

S. No.	Square root of Time	%CR
0	0	0
1	1	5.68
2	1.414214	12.21
3	2	28.77
4	2.44949	51.65
5	3.162278	74.25
6	3.464102	89.46
7	4.898979	96.31

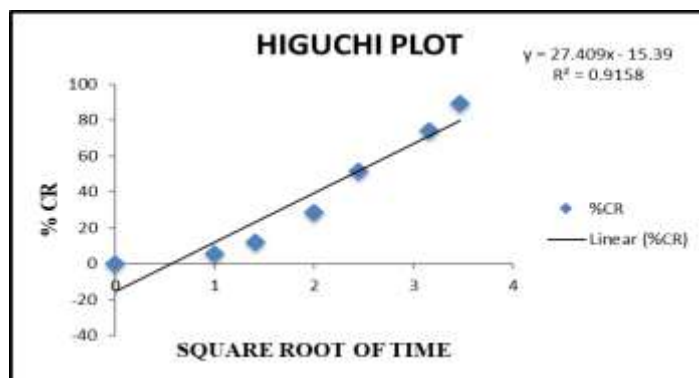


Figure 8.8: Higuchi plot for optimised formulation.

Korsmeyer -Peppas Model for Mechanism of Drug Release

Table 8: Table shows Korsmeyer-Peppas Model Of Metformin HCl Liposomes.

S. No.	log T	log %CR
0	∞	0
1	0	0.754348
2	0.30103	1.086716
3	0.60206	1.45894
4	0.778151	1.71307
5	1	1.870696
6	1.079181	1.951629
7	1.380211	1.983671

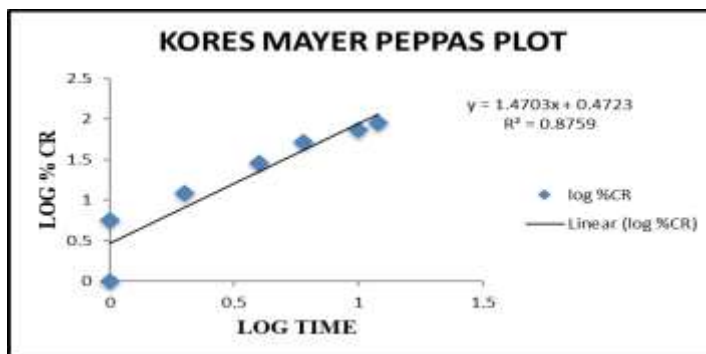


Figure 8.9: Koresmayer peppas plot for optimised formulation.

Hixion Crowell Release Model of Metformin HCl Optimization Formulation

Table 9: Table shows hixion crowell release model of metformin hcl optimization formulation.

S. No.	Time	Cube root of %drug remaining
0	0	4.641589
1	1	4.55199
2	2	4.444419
3	4	4.145284
4	6	3.643053
5	10	2.95297
6	12	2.192537
7	24	1.545286

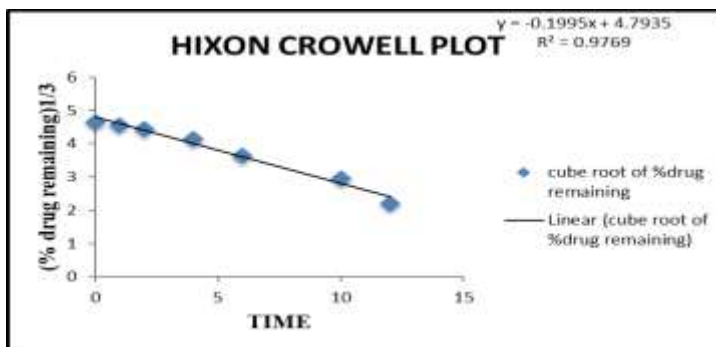


Figure 8.10: Hixion crowell plot for optimized formulation.

Curve fitting data of release rate profile of formulations F1 To F6

Table 10: Table shows Curve Fitting Data of Release Rate Profile of Formulations F1 to F6.

Formulation code	Zero order(r ²)	First order(r ²)	Higuchi (r ²)	Hixion crowell(r ²)	kosermeyer-peppas (r ²)	kosermeyer-peppas Slope (n)
F1	0.988	0.885	0.929	0.957	0.821	1.414
F2	0.992	0.941	0.915	0.976	0.875	1.470
F3	0.971	0.966	0.956	0.991	0.763	1.353
F4	0.959	0.953	0.961	0.985	0.721	1.316
F5	0.963	0.954	0.968	0.990	0.714	1.310
F6	0.952	0.978	0.976	0.994	0.683	1.276

Stability Studies: The liposomal formulation was tested for a period of 8 weeks at different temperatures of 25°C

and 40°C with 60% RH and 75%RH for their drug dissolution.

Stability Dissolution Results of Optimized Formulation-F2

Table 11: Table shows Stability Dissolution Results of Optimized Formulation-F2.

Formulation Code	Parameters	Initial drug release after 24 hrs	After 1 st Month	After 2 nd Month
F2	25°C/60%RH % Release	96.31	96.3	96.29
F2	30°C/75% RH % Release	96.31	96.29	96.28
F2	40°C/75% RH % Release	96.31	96.28	96.28

Drug-Excipient Compatibility Studies

The compatibility in between the drug as well as the picked lipid as well as various other excipients was assessed using FTIR optimal matching approach. There

was no look or loss of tops in the drug-lipid blend, which verified the absence of any kind of chemical communication between the drug, lipid and various other chemicals.

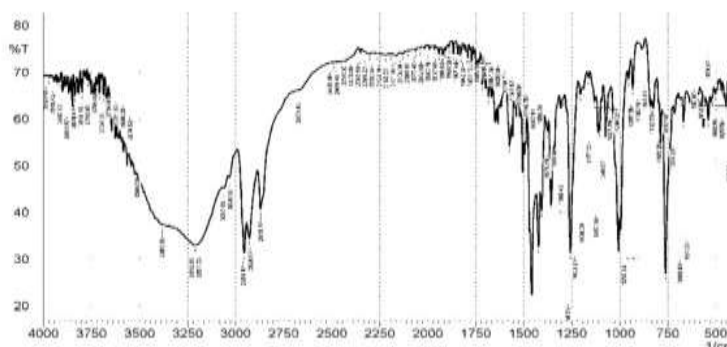


Figure 8.11: FTIR of Metformin HCl Spectrum.

Table 12: Interpretations of FTIR Spectra for Pure Drug Metformin HCl.

S. No.	Functional groups	Range of groups Wave number cm^{-1}	Assessment of peak Wavenumber cm^{-1}
1.	N-H stretching	3400-3500	3489.23,3442.94,3064.89
2.	C-H stretching (Alkane)	2960-2850	2939.52,2899.01,2823.79,2044.54
3.	C=O stretching (Aldehyde)	1720-1740	1722.43
4.	N-H bending	1500-1650	1625.99,1602.85,1585.49,1566.20
5.	C=C stretching (Aromatic)	1450-1600	1496.76,1452.40
6.	C-N vibration	1000-1400	1390.68, 1369.46, 1315.45, 1269.16, 1246.02, 1168.86, 1101.35, 1074.35, 1026.13
7.	C-H bendig (Aromatic)	750-850	850.61, 827.48, 804.32, 777.31, 748.38, 705.95

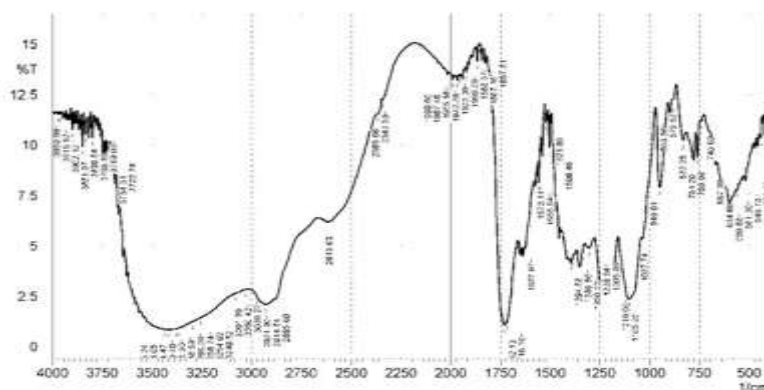


Figure 8.12: FTIR of Optimized formulation.

Table 13: Interpretation of FTIR Spectra optimized Formulation.

S. No.	Functional groups	Range of groups Wavenumber cm^{-1}	Assessment of peak Wavenumber cm^{-1}
1.	N-H stretching	3400-3500	3417.86
2.	C-H stretching (Alkane)	2960-2850	2931.80
3.	C=O stretching (Aldehyde)	1720-1740	1720.50
4.	N-H bending	1500-1650	1627.92, 1620.21, 1602.85, 1585.49
5.	C=C stretching (Aromatic)	1450-1600	1492.90,1454.33
6.	C-N vibration	1000-1400	1369.46, 1315.45, 1269.16, 1246.02, 1170.79, 1141.86, 1101.35, 1056.99, 1024.20
7.	C-H bendig (Aromatic)	750-850	846.75, 827.46, 802.39, 777.31, 744.52, 705.95

SUMMARY AND CONCLUSION

Metformin HCl liposomes were readied utilizing soya lecithin, cholesterol, Tween80, just as chloroform as dissolvable by meager film hydration procedure using pivoting evaporator. The readied Liposomes were evaluated by prescription entanglement study, bit measurement investigation. Managed impregnation medication discharge study and furthermore arrangement of dispatch energy utilizing Higuchi's plot and furthermore korsmeyer Peppas story and furthermore strength investigates.

The result of prescription ensnarement adequacy of liposomes proposes that as the focal point of phosphatidyl choline brings down, medication capture viability of liposomes lessens which was because of the immersion of lipid bilayer regarding the medication where low phosphatidyl choline web content offers negligible entanglement capacity. The exemplification proficiency of liposomes is constrained by the capacity of equation to keep up prescription atoms in the fluid center or in the bilayer film layer of the rankles. Cholesterol supports the ease of the bilayer film just as improves the steadiness of bilayer film layer in the perceivability of natural fluids, for example, blood/plasma.

Consequences of molecule measurement assessment demonstrated that, as the grouping of cholesterol raises molecule size expands which was may be a direct result of development of inflexible bilayer structure anyway this was up to a subtleties focus as there was in like manner lower in size of arrangement F2.

The active treatment of the medication dispatch information of the prepared definitions followed no organization tranquilize discharge; the prepared arrangements consented to Higuchi account, as the plot uncovered high linearity ($R^2 = 0.992$) demonstrating dissemination as one gadget of medication dispatch. F2 indicated high linearity in Hixon story ($R^2 = 0.976$) and Korsmeyer-Peppas story incline esteem "n" was 1.470 the adored one multifaceted nature of this recipe and its parts may recommend incredibly case-II transportation for example that the medication dispatch is overseen by more noteworthy than one procedure.

The dependability of the Metformin HCl liposomes was checked for a time of about two months at different temperature levels of 25°C and furthermore 40°C with 60% RH and furthermore 75% RH for their prescription dissolution. The drug arrival of the example was resolved as an element of the capacity at various timeframes. The liposomes put away at 25°C and 40°C were seen as consistent for time of two months. At last, the Metformin HCl stacked liposome definition had great ability to embody medication and produced positive physicochemical characteristics. The stomach related

parcel retention just as antitumor limit of Metformin HCl was fundamentally upgraded by using liposomes. These outcomes suggest that liposomes could be a promising perioral specialist co-op for Metformin HCl.

From the actualized trial results, it could be wrapped up that the lipids like Soya lecithin, Cholesterol just as Tween80 appropriated transporter for the planning of Metformin HCl Liposomes. In spite of the fact that the primer information dependent on in-vitro disintegration profile, dispatch energy just as security investigates confirmed that the practicality of such arrangements, Still a total test will be called for dependent on the pet explores.

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